Proceedings of
the United States
National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 121 1967 Number 3574

COPEPOD CRUSTACEANS PARASITIC ON TELEOST FISHES OF THE HAWAIIAN ISLANDS [1]

By Alan G. Lewis [2]

Introduction

This is the third and last of a series of papers covering the copepod parasites of Hawaiian fishes. The first (Lewis, 1964a) deals with the caligoid copepod parasites of Hawaiian acanthurid fishes, the second (Lewis, 1966) covers the copepod crustaceans parasitic on elasmobranch fishes, and the present paper deals with copepod crustaceans parasitic on teleost fishes. An additional paper (Lewis, 1964b), dealing with the caligoid genus *Dentigryps*, includes descriptions of two species found on Hawaiian fishes.

Other than the papers mentioned above, the references to copepods taken from Hawaiian teleosts are those of Nordmann (1864), describing *Norion expansus* and *Peniculus calamus* from unknown hosts, and Edmondson (1946), who figures a species of *Lernaeenicus* from dolphins. Bonnet (1948) lists some Hawaiian copepods taken primarily from pelagic fishes, and Shiino (1963) describes *Midias lobodes*, *Caligus coryphaenae*, and *Brachiella thynni* from fishes examined in the Honolulu Fish Market. In addition to these, Randall

[1] This study was supported by grants (G–24956 and GB–2464) from the National Science Foundation.

[2] Associate Professor of Oceanography, Institute of Oceanography, University of British Columbia, Vancouver, Canada.

(1958) lists, by family, the copepods taken from the stomachs of some parasite-picking fishes of the genus *Labroides* and (1961) the parasitic copepods taken from the Manini (*Acanthurus triostegus sandvicensis*).

The study here reported has benefited from collections made by the Honolulu division of the U.S. Fish and Wildlife Service and from the assistance given to the author by the Division of Marine Invertebrates of the Smithsonian Institution, especially by Drs. Bowman, Manning, and Cressey, whose assistance with the synonymies is deeply appreciated. The author is also grateful to the officers and crew of the U.S. Coast Guard vessel *Buttonwood* and to Lester Zukeran and Samuel Kaolulo for the collection of both host and copepod material.

Methods.—The external surface, gill cavities, buccal cavity, and nasal cavities of the teleost hosts were examined for parasitic copepods. Copepods collected were killed in either 95 percent ethyl alcohol or 10 percent formalin and later transferred to 95 percent ethyl alcohol. Specimens to be drawn or dissected were placed in 85 percent lactic acid to clear and soften them, stained with Chlorazol Black E dissolved in 85 percent lactic acid, and then placed in benzyl alcohol for final clearing and for dissection and drawing.

Drawings of the entire animal were made from specimens placed in benzyl alcohol and covered with a cover slip, supported so that the shape of the organism was not distorted. Both a camera lucida and a Bausch and Lomb Tri-Simplex Micro-Projector were used in making the drawings. The appendages and processes were drawn in situ or were removed and mounted in either Hoyer's mounting medium or a 1:1 mixture of Turtox's CMC–10 and CMC–S. Measurements were made with an ocular micrometer on specimens softened in lactic acid and held loosely in place by a cover slip supported by spacers.

In the following figures the ♀ and ♂ signs are used separately under each drawing to indicate a difference between the appendage or body part of the female and that of the male. The symbols are used together (♀ ♂) to indicate the similarity of the appendage or body part in both sexes. In the latter case the sex of the specimen from which the drawing is made is indicated by a line under the appropriate symbol. If only one sex is represented in the collection, the symbols are not used.

Terminology.—The term "cephalothorax" is used to indicate a condition in which one or more of the thoracic segments are fused with the cephalon. The maxilliped-bearing segment is considered as the first thoracic segment. The term "pedigerous segment" is used to indicate a leg-bearing thoracic segment, while the terms "free thoracic segments" or "free pedigerous segments" are used to designate those thoracic segments that are not fused with the cephalon. The term "genital segment" is used, although with some question, to designate the fused sixth and seventh thoracic segments (=fifth and sixth pedigerous segments) in the Caligidea (Caligoidea of Yamaguti, 1963). In the lernaeocerids, pennellids, and lernaeopodoids, the terms "cephalothorax" and "trunk" are used. The term "cephalothorax" has the same meaning as that given above, while the term "trunk" designates the region immediately posterior to the cephalothorax. The term "ovigerous" is used to indicate a female with egg strings, the term "nonovigerous" to indicate a female without egg strings even though the genital segment (or trunk) may contain eggs.

With three exceptions, the terminology applied to the appendages and processes is the same as that in Lewis (1964a). Thus, the term "antennules" refers to the first antennae and the term "antennae" refers to the second. The term "mandibles" refers to the pair of appendages immediately adjacent to the mouth and normally projecting into a "mouth cone" if it is present. The term "maxillipeds" refers to the modified pair of appendages on the first thoracic segment, while the "sternal furca" is a bifurcate, posteroventrally directed projection between and slightly posterior to the maxilliped bases of trebiids, euryphorids, and caligids. The term "thoracic legs" designates the pair of semifoliaceous or foliaceous appendages arising from some of the thoracic segments posterior to the first or maxilliped-bearing segment, while the "caudal rami" are the pair of appendages at the posterior end of the body.

The three exceptions to the original terminology have arisen from a recently completed study made by the author on the nature of the maxillae in the Caligidea (ms in preparation). It appears that the setule- or seta-bearing node lateral to the mouth cone of this group of caligoids is the maxillule, but it seems that the spine or plate immediately behind this structure in the trebiids, eirgids, euryphorids, and caligids is an accessory formation and not part of the maxillule. The name "maxillule" is now given to the setule-bearing node (maxillary palp of Yamaguti, 1963), while the term "postoral process" refers only to the spine or plate immediately behind the maxillule. The term "maxillae" applies to the second pair of maxillae with its associated pair of openings to the maxillary glands. The term "postantennal process" is used to designate the process-bearing nodules and the spinelike projection, if present, situated lateral and slightly posterior to the base of the antenna.

To facilitate the use of the thoracic leg tables, a hypothetical thoracic leg is shown in figure 1, giving the various thoracic leg armature elements used in the tables. Further, an analysis of the hypothetical thoracic leg is given in table 1.

In the section entitled "Material" for each of the species, the abbreviation USFWS means U.S. Fish and Wildlife Service, HMS means the USFWS vessel *Hugh M. Smith*, CHG the USFWS vessel

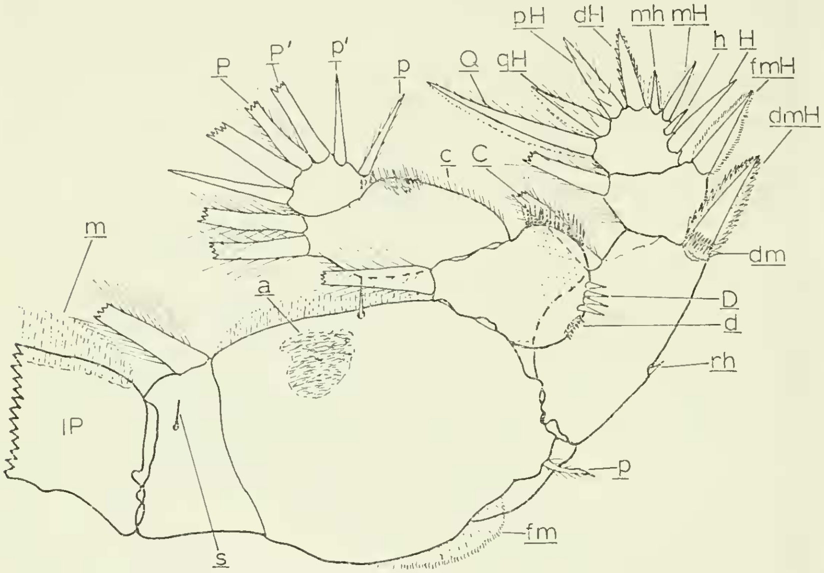


FIGURE 1.—Hypothetical thoracic leg showing various armament components:

a: adhesion surface
C: heavy fringing plumosities
c: light fringing plumosities
D: large denticulations
d: small denticulations
dH: large denticulated spine
dm: denticulated membrane
dmH: large spine with denticulated membrane
fm: frilled membrane
fmH: large spine with frilled membrane
H: large spine
h: small spine
IP: interpodal plate
m: membrane
P: plumose seta
p: plumose setule
P′: naked seta
p′: naked setule
pH: large plumose spine
Q: seta plumose on one side and membranous on other
qH: large spine plumose on one side and membranous on other
rh: spinule
s: solitary hairlike process

TABLE 1.—*Armature of hypothetical thoracic leg shown in figure 1*

Leg	Surface	Interpodal Plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
	Outer	m		fm,p	rh,dm, dmH	fmH	H,h,mH, mh,dH	d,D, C	c	d,p,p′,P′, P
	Inner		s,P	m,a,s	c,P	c,P	c,Q,qH,pH	P	c,2P	c,p′,P″

Charles H. Gilbert, JRM the USFWS vessel *J.R. Manning,* and LL means a USFWS longline cruise on board a chartered vessel.

The names of the Hawaiian fishes that served as hosts are taken from the "Handbook of Hawaiian Fishes" by Gosline and Brock (1960). The names of previously reported hosts are as they appear in the references giving these hosts.

A list of the Hawaiian fishes examined is given following the descriptions. Included in this list are the species of copepods found on each of the hosts.

Order Cyclopoida

Family Bomolochidae

Pseudotaeniacanthus Yamaguti and Yamasu, 1959

Diagnosis.—Body cyclopoid, cephalon fused with first 2 thoracic segments, slightly broader than rest of prosome; second to fifth pedigerous segments gradually narrowed posteriorly, projecting laterally over respective protopodites; fifth pedigerous segment not appreciably expanded laterally. Abdomen 4-segmented. Antennule 5- or 6-segmented; antenna uniramous, with 4 clawlike terminal spines. Postantennal processes present, fused, Y-shaped, with rows of spinules giving brushlike appearance, with or without large, posterior hooks at apex of Y. Maxillule setiferous; maxillae as in other bomolochids or reduced; maxilliped clawlike in male, reduced in female. Thoracic legs 1–4 biramous, rami 3-segmented; endopodite of first leg longer than exopodite, with few marginal setae; fifth and sixth legs uniramous.

Pseudotaeniacanthus puhi, new species

Figures 2, 3

Material.—One adult female (holotype, USNM 112862), 1 adult male (allotype, USNM 112863), 12 adult females, and 8 adult males (paratypes, USNM 112864) from the gill cavity of a "Brown Moray" from the Honolulu Aquarium. One adult female and 1 adult male (paratypes, USNM 112865) from the gill cavity of a "Green Moray" from the Honolulu Aquarium.

Measurements.—(In mm) 14 females and 10 males:

	female		*male*	
	mean	*range*	*mean*	*range*
Greatest length, excluding caudal setae	1.15	0.92–1.27	1.05	0.92–1.18
Length of prosome	0.78	0.68–0.88	0.66	0.54–0.74
Width of prosome	0.39	0.35–0.42	0.37	0.32–0.42
Length of cephalothorax	0.30	0.27–0.32	0.32	0.28–0.37
Length of genital segment	0.10	0.09–0.12	0.11	0.08–0.14
Width of genital segment	0.14	0.13–0.15	0.14	0.13–0.16
Length of egg sac (3 sacs)	0.16, 0.18, 0.48			

Description.—Female cephalothorax (fig. 2*a*) bell shaped, consisting of cephalon, maxilliped-bearing, and first pedigerous segments. Second pedigerous segment distinct from and slightly narrower than cephalothorax; third pedigerous segment distinct from and slightly narrower than second; fourth pedigerous segment distinct from and slightly narrower than third, broadly rounded posteriorly. Fifth pedigerous segment approximately half the width of fourth, anterior end overhung by posterior end of fourth pedigerous segment. Genital segment (fig. 2*c*) distinct from fifth pedigerous segment, lateral margins convex; oviducal opening surrounded by series of small sclerites. Remaining urosome segments 4 in number, each tapered slightly, narrower and shorter than preceding segment. Caudal ramus (fig. 2*f*) subrectangular, short, with 2 long and 3 short terminal setae.

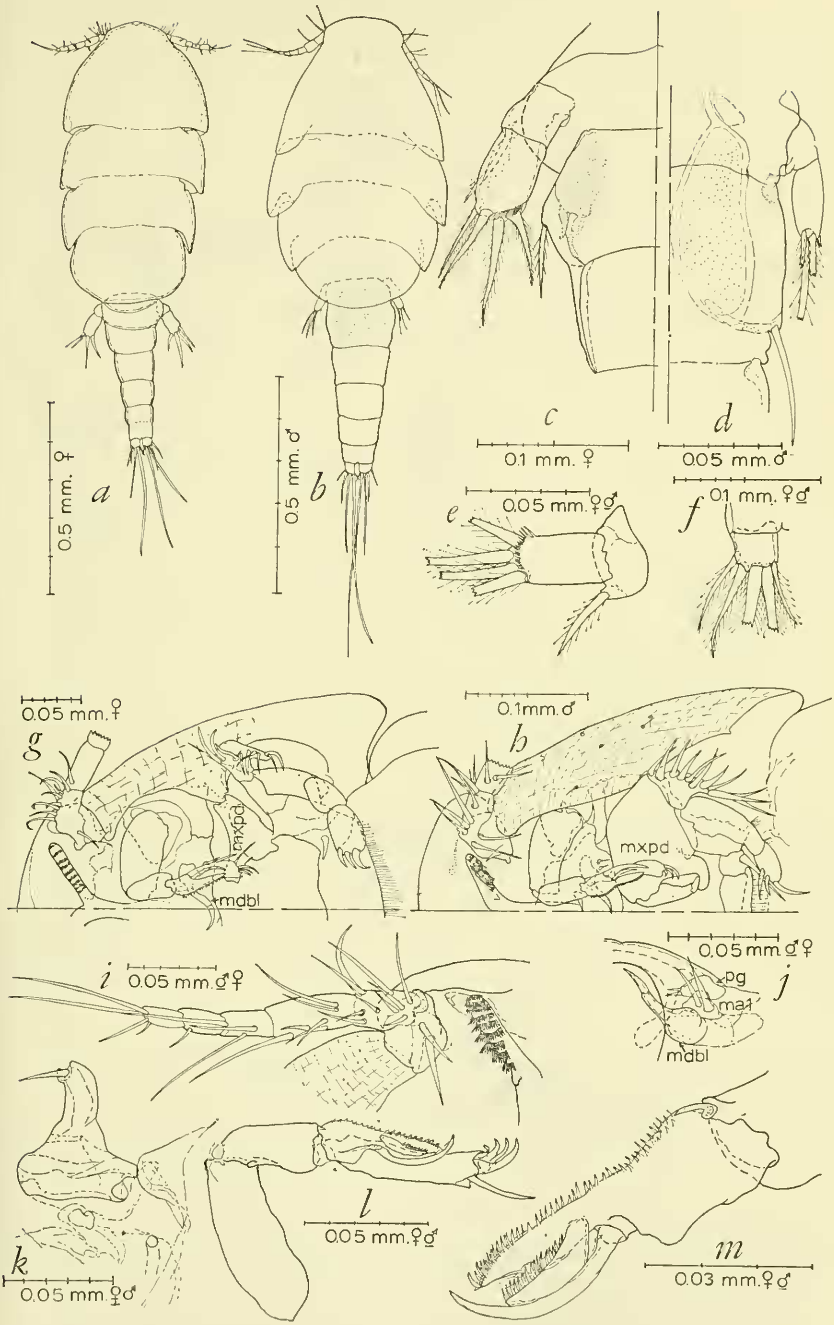
Male prosome (fig. 2*b*) more ovoid than that of female, general makeup otherwise similar. Urosome tapered, genital segment (fig. 2*d*) similar in shape to remaining 4 urosome segments although larger.

Female and male antennule (fig. 2*i*) 5- or 6-segmented, proximal segment expanded on proximal posterior surface. Female and male antenna (figs. 2*l*, *m*) uniramous, 3-segmented, situated posterior and slightly lateral to antennule base; first segment approximately one and one-half times the length of second, both segments without armature. Third segment elongate, length slightly less than that of first segment, proximal portion with folded, flaplike extension with denticulations, naked seta and large, spinelike projection distally (fig. 2*m*) Distal end of third segment with 1 naked seta and 4 clawlike spines.

Female and male mandible (fig. 2*j*) rodlike, 2-parted. First part tapered slightly from proximal to distal end, second part tapered to pointed distal end, curved inward slightly distally. Female and male with Y-shaped postantennal process on anterior ventral surface (fig. 2*i*), arms of Y with 9–10 transverse rows of spinules giving brushlike appearance. Female and male maxillule (fig. 2*j*) situated immediately posterior to mandible base, consisting of pair of setae attached to platelike area of heavy sclerotization contiguous with posterior edge of platelike area of heavy sclerotization forming attachment surface for mandible. Maxilla (fig. 2*k*) represented by large,

---

Figure 2.—*Pseudotaeniacanthus puhi*, new species, dorsal view: *a*, female; *b*, male. Fifth pedigerous segment, fifth leg, genital segment, sixth leg, and first abdominal segment: *c*, female; *d*, male, same, also includes anterior end of first abdominal segment. Right fifth leg: *e*, posterior view. Ventral view: *f*, caudal ramus; *g*, female cephalothorax (mdbl= mandible, mxpd=maxilliped); *h*, male cephalothorax (mxpd=maxilliped); *i*, right antennule and heavily sclerotized postantennal process; *j*, right mandible (mdbl), maxillule (ma-1), and paragnath (pg); *k*, maxilla; *l*, antenna; *m*, projection on proximal portion of third segment of antenna.


0.5 mm. ♀
a
0.5 mm. ♂
b
c
0.1 mm. ♀
d
0.05 mm. ♂
e
0.05 mm. ♀♂
f
0.1 mm. ♀♂
g
0.05 mm. ♀
mxpd
mdbl
h
0.1mm. ♂
mxpd
i
0.05 mm. ♂♀
j
0.05 mm. ♂♀
pg
ma1
mdbl
k
0.05 mm. ♀♂
l
0.05 mm. ♀♂
m
0.03 mm. ♀♂

heavily sclerotized, knoblike projection posterior and lateral to oral region. Knob with broad base, tapered to narrow distal region with

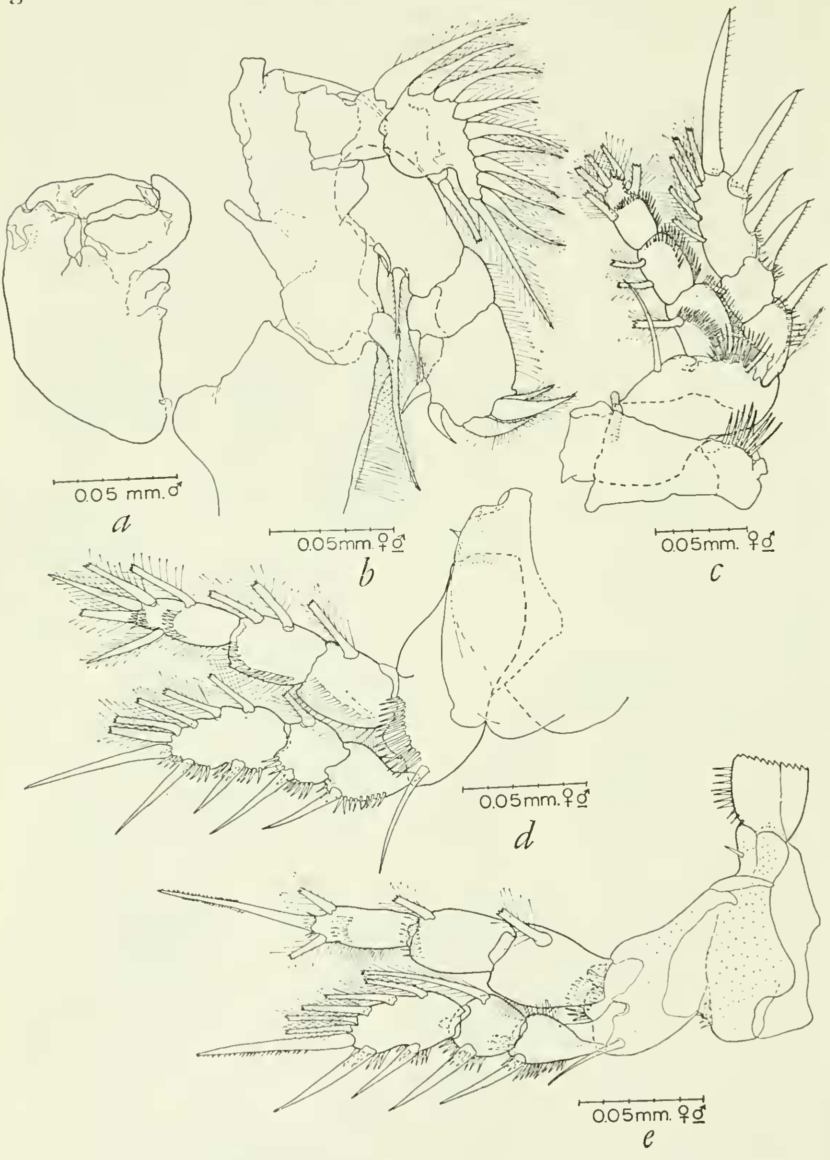


FIGURE 3.—*Pseudotaeniacanthus puhi*, new species: *a*, male maxilliped, ventral view. Thoracic legs: *b*, left first, anterior view; *c*, left, second, posterior view; *d*, right third posterior view; *e*, right fourth, posterior view.

medially facing cuplike indentation, indentation bearing single, seta-like process. Female and male paragnath (fig. 2*j*) minute, situated immediately posterior to maxillule, consisting of single, flabby, subconical projection bearing pair of setules distally.

Female maxilliped (fig. 2*g*) knoblike, broad based, distally concave, without armature. Male maxilliped (fig. 3*a*) 2-segmented, first segment large, strongly developed, narrow proximally, broad distally, with 3 small, lappet-like projections along inner surface and single, large, distally recurved projection from distal inner surface. Second segment fused with clawlike terminal process, bearing single, accessory seta proximally.

For nature of legs and armature, see figures 2*c–e*, 3*b–e*, and table 2.

TABLE 2.—*Armature of thoracic legs 1–4 of the female and male of* Pseudotaeniacanthus puhi, *new species*

Leg	Surface	Interpodal Plate	Protopodite 1	Protopodite 2	Exopodite 1	Exopodite 2	Exopodite 3	Endopodite 1	Endopodite 2	Endopodite 3
I	Outer	c	p			P	9P	c	c	c,3P
	Inner		P				P	p	p	2P′
II	Outer	D	D	P D	D, pH*	D, pH*	D, pH*, D, 2pH	2D	2D	2D, P, 2D, 2P
	Inner			P′	c	P	5P	P	2P	2P
III	Outer	D	D	P D	D, pH	D, pH	D, pH, D, 2pH	C, D	C, D	C, D, P, 2D, 2P
	Inner		rh		c	P	5P	P	2P	2P
IV	Outer	D	D	P D	D, pH	D, pH	D, pH, D, 2pH	2C	C, D	C, 2D, 2pH
	Inner		rh		c	P	5P	P	P	P

*Present on female, male = H.

DISCUSSION.—*Pseudotaeniacanthus puhi* differs from *P. congeri* Yamaguti and Yamasu, 1959, primarily in not having the large "posterior hooks" of the latter species, in the armature of the thoracic legs, and in the smaller thoracic pleura. The species name is derived from "Puhi," the Hawaiian name for moray eels, the host of the species.

Anchistrotos Brian, 1906

DIAGNOSIS.—Body cyclopoid, cephalothorax consisting of cephalon and first 2 thoracic segments. Cephalothorax the broadest part of prosome, 3 free prosomal segments tapering posteriorly. Small frontal region present, with rostrum. Abdomen 3- or 4-segmented; caudal rami short. Antennule 6- or 7-segmented, proximal segments not fused; antenna 3-segmented, distal segment with pectinate margin, bearing terminal claws and setae. Mandible 2-segmented, second segment with terminal blade and subterminal palp. Postantennal process well developed, clawlike. Maxillule nodular or conical, typically with 5 associated setae or setules; maxilla tipped with pectinate blade, with 1–2 subterminal setalike or palplike processes. Maxilliped with or without claw. Thoracic legs 1–4 biramous, first with 2- or 3-segmented rami; second to fourth with 3-segmented rami. Fifth legs uniramous, 2-segmented; sixth legs setiform or lacking.

Remarks.—*Anchistrotos* is quite similar to *Taeniacanthus;* the only consistent difference appears to be that the length of the caudal rami of *Anchistrotos* is shorter than that of *Taeniacanthus.* The variation in this characteristic, however, is such that no distinct relationship can be stated. Yamaguti (1963) uses the presence of a "rostral projection at center of frontal margin" as a key characteristic to separate *Anchistrotos* from the remaining taeniacanthins, but this projection is not present in *A. occidentalis* Wilson, 1924, and is not apparent from the figures of several other species of the genus. Additionally, the frontal region of members of *Anchistrotos* and *Taeniacanthus* is similar. Wilson (1911a, p. 387) states that "the three basal joints [of the antennule are] thoroughly fused . . ." in the diagnosis of the genus *Taeniacanthus.* If this characteristic had been used in later descriptions (e.g., *Taeniacanthus sebastichthydis* Yamaguti, 1939a), it would have provided a better means of separating the two genera.

The following species is included in the genus *Anchistrotos* because it does have a slight rostral projection, the caudal rami are "short," the proximal 3 segments of the antennule are not fused, and, in general, the other characteristics most closely approximate those of the species previously described for the genus.

Anchistrotos moa, new species

Figures 4, 5

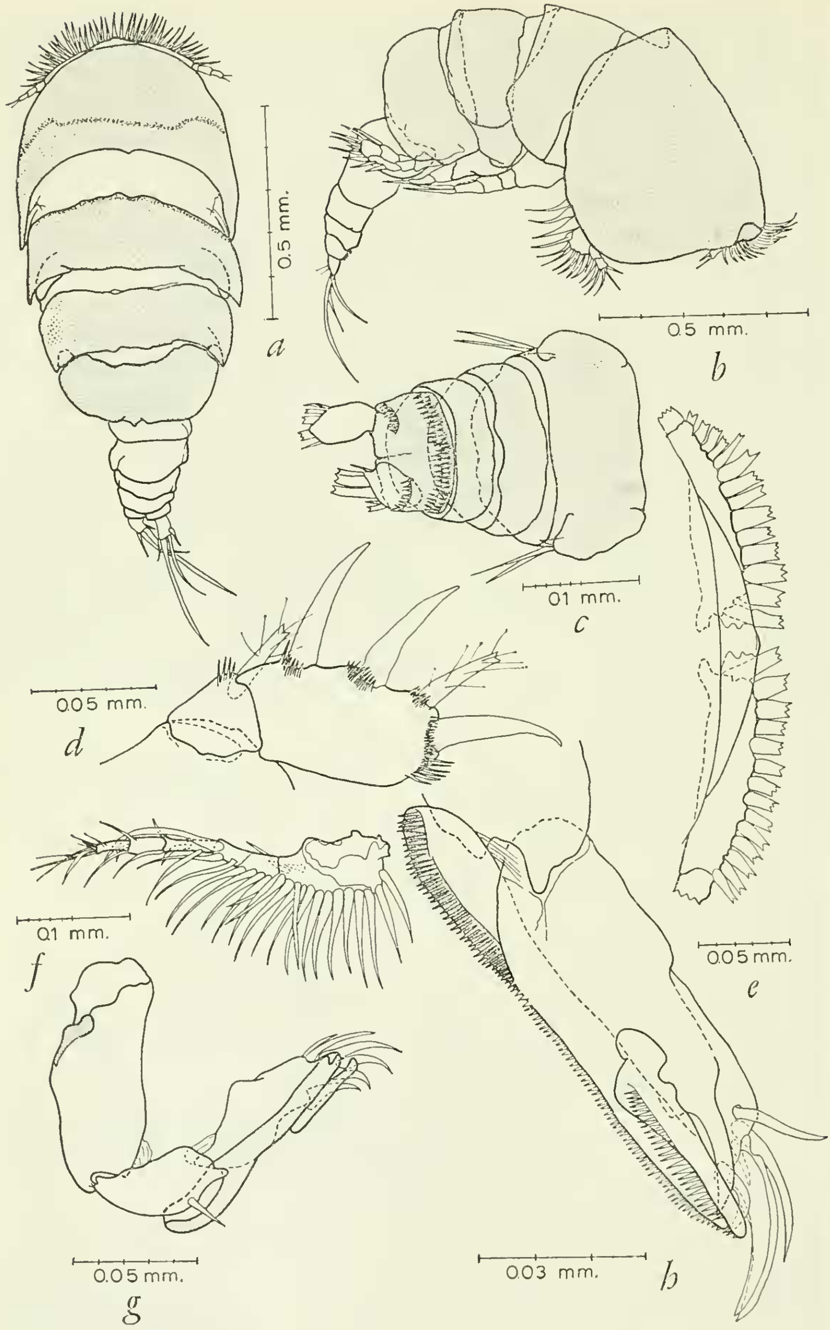
Material.—Two adult, nonovigerous females (holotype, USNM 112866; paratype, USNM 112868) from a specimen of *Ostracion lentiginosus* captured at Rabbit Island, adjacent to Oahu, Hawaii. Two adult nonovigerous females (paratypes, USNM 112867) collected from a second specimen of *O. lentiginosus* captured at Rabbit Island. All 4 specimens were given to the author without information concerning their location on the host.

Measurement.—(In mm) 4 females:

	mean	*range*
Greatest length, excluding caudal setae	0. 76	0. 70–0. 85
Length of prosome	0. 57	0. 52–0. 62
Width of prosome	0. 40	0. 34–0. 43
Length of cephalothorax	0. 33	0. 30–0. 36
Length of genital segment	0. 07	0. 06–0. 07
Width of genital segment	0. 13	0. 12–0. 14
Length of egg sac (1 sac)		0. 55

Description of female.—Body (figs. 4*a*, *b*) of general taeniacanthiform nature. Cephalothorax consisting of cephalon, maxilliped-bearing, and first pedigerous segments; second through fourth pedigerous segments distinct. Frontal region (fig. 4*e*) narrow, unarmed except for small, slightly projecting rostrum. Cephalothorax projecting ventrally well below ventral surface, extending posteriorly over lateral anterior surface of second pedigerous segment, with irregular, heavily sclerotized band across dorsal surface of posterior region. Second, third, and fourth pedigerous segments decreasing in width, with ventrally and posteriorly projecting extensions as on cephalothorax except not as well developed. Fourth pedigerous segment rounded posteriorly, extending over dorsal surface of fifth pedigerous or first urosomal segment. Genital segment (fig. 4*c*) indistinctly swollen, slightly larger than fifth pedigerous segment; sixth legs present as pair of very lightly plumose setae and spinule-like projection immediately posterior to oviducal openings. Abdomen 3-segmented, segments diminishing in length and width, from dorsal viewpoint. Ventral surface of third abdominal segment with 2 rows of minute spinules anteriorly, separated by pair of larger spinules medially, and incomplete row of spinules in region of attachment of caudal rami (fig. 4*c*). Caudal rami short, slightly longer than wide, with 2 long, lightly plumose median setae, 2 short outer setae, and 1 inner setule on distal surface.

Antennule (fig. 4*f*) 7-segmented although segmentation not completely distinct, first and second segments and third and fourth segments appearing partially fused. First segment with 5 lightly plumose setae along anterior surface; second with 11 on anterior, 3 on dorsal surface; third segment with 4 or 5 plumose setae anteriorly; fourth with 3; fifth with 4; sixth with 3 naked setules; seventh with one naked setule from distal posterior surface, 3 small, naked setules from posterior distal surface, 3 long, naked setules and one aesthete(?) from anterior distal surface. Antenna (figs. 4*g*, *h*) uniramous, 3-segmented; first segment tapered slightly toward distal end, with slight knob on outer distal corner. Second segment slightly more than half the length of first, with small spine on distal inner surface; third segment 1½ times the length of second, with large, elongate projection on inner surface, extending from distal end of segment proximally, past proximal end to form cup-shaped projection overlapping distal half of second segment. Additional irregularly awl-shaped projection present on distal ventral surface, projecting past distal end of segment. Both projections with complete marginal denticulations. Additional armature of third segment consisting of 3 naked setules and 4 clawlike spines distally.


0.5 mm.
a
0.5 mm.
b
0.1 mm.
c
0.05 mm.
d
0.05 mm.
e
0.1 mm.
f
0.05 mm.
g
0.03 mm.
h

Mandible (fig. 5*a*) 2-segmented, first segment slightly longer than second, second bearing 2 short, flattened, pectinate processes distally, ventralmost longest. Postantennal process (fig. 5*b*) well developed, consisting of spinelike falciform projection slightly posterior to antennule base and directed posteroventrally; base heavily sclerotized and enlarged, tip sharply pointed. Maxillule (fig. 5*a*) nodular, situated immediately posterior to mandible base, bearing 2 long, very lightly plumose setae, 1 shorter naked seta and 2 minute setules. Maxilla (figs. 5*a*, *c*) with one distinct segment although indication of second segment fused with cephalothorax; armature of distinct segment consisting of 2 spikelike projections, one subterminal and very lightly plumose, second terminal, finely denticulated along inner margin. Paragnath (fig. 5*a*) lobate, curved inward sharply, with slightly fuzzy distal end.

Maxilliped (fig. 5*d*) 2-segmented although indication of third segment suggested by heavily sclerotized, platelike process intimately associated with cephalothorax but forming articulation surface for maxilliped. First segment elongate, with 1 or 2 naked setae arising from slight depression of median posterior surface. Second segment with long, indistinctly separable falciform process, distal end of segment with nodular swelling bearing 1 or 2 naked, setule-like accessory processes.

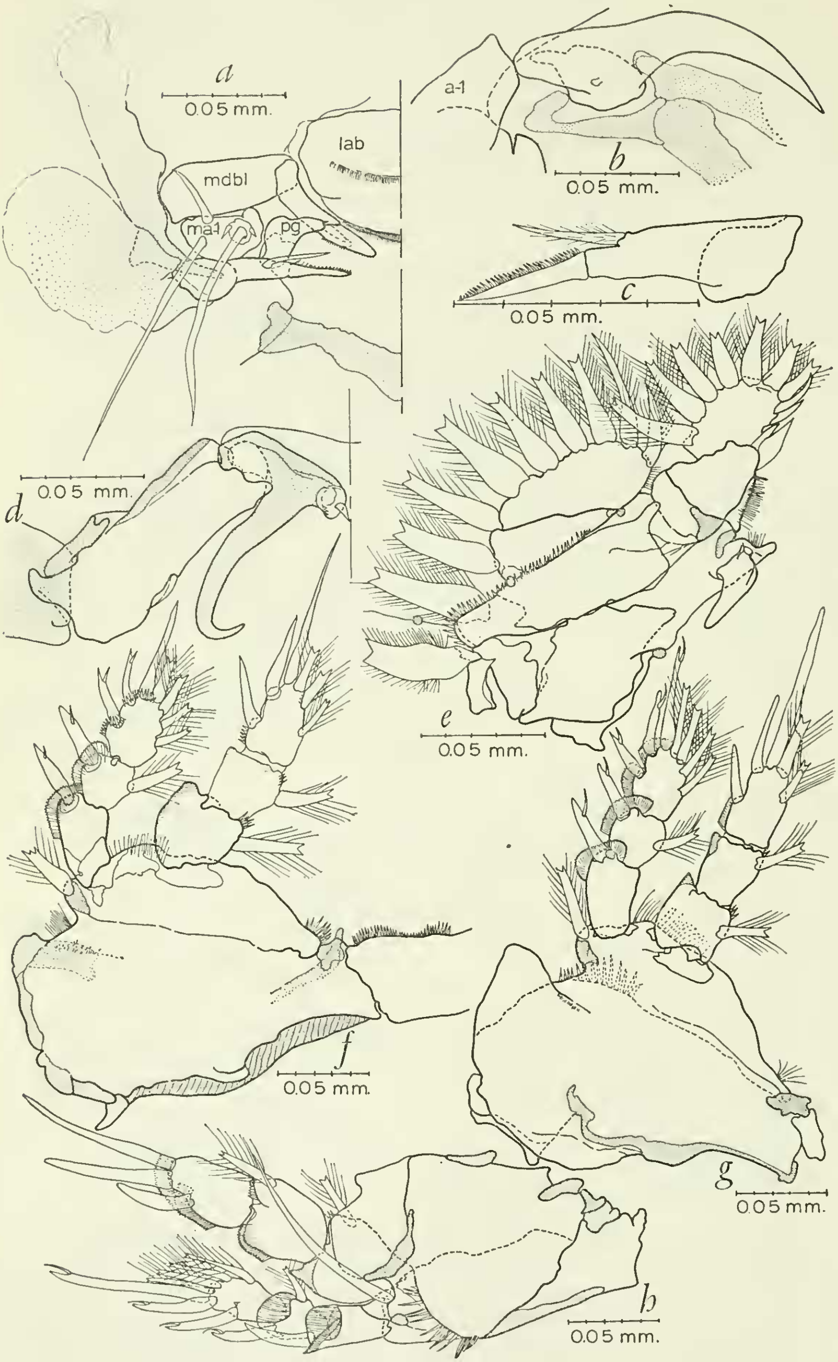
For nature of legs and armature see figures 4*c*, *d*, 5*e–h*, and table 3.

TABLE 3.—*Armature of thoracic legs I–V of the female of* Anchistrotos moa, *new species*

Leg	Surface	Interpodal Plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer	C	c,P		2H	2H,P			c	
	Inner		2P,d			6P		P	7P	
II	Outer	C	c,P		dm,H	dm,H	2dm,3H			dm,3H
	Inner		C			P	4P	P,C	P,C	3P
III	Outer	C	C,P		dm,H	dm,H	2dm,3H			dm,3H
	Inner		c,c			P	4P	P,C	P,C	2P
IV	Outer	C	C,P		dm,H	dm,H	3H		dm	2dm,3H
	Inner					P	4P	P,C	P,C	
V	Outer		C,P*		dm,2H, dm, P, dm, H,C*					

*Designation under protopodite and exopodite for convenience; association of segment uncertain.

FIGURE 4.—*Anchistrotos moa*, new species, female: *a*, dorsal view; *b*, lateral view; *c*, genital segment, sixth legs, abdomen, and caudal rami, ventral view; *d*, fifth leg, ventral view; *e*, rostrum, frontal region and proximal segment of antennules, dorsal view; *f*, right antennule, dorsal view (setal plumosities not figured); *g*, antenna, ventral view; *h*, third segment of antenna, dorsal view.


a
0.05 mm.
lab
mdbl
ma-1
pg
a-1
c
b
0.05 mm.
c
0.05 mm.
0.05 mm.
d
e
0.05 mm.
f
0.05 mm.
g
0.05 mm.
h
0.05 mm.

Discussion.—*Anchistrotis moa* is most closely related to *A. ostracionis* (Richiardi, 1870). The overhanging tergal regions of the cephalothorax and prosomal pedigerous segments of *A. moa*, the absence of the small basal projection found on the postantennal process of *A. ostracionis*, and the nature of the spination on the ventral surface of the third abdominal segment are the most readily distinguished characteristics which separate the two species. The species name is derived from "Moa," one of the Hawaiian names for *Ostracion lentiginosus*, the host of this copepod.

Order Caligoida

Family Dichelesthiidae

Hatschekia Poche, 1902

Diagnosis of female.—Cephalothorax consisting of cephalon and first thoracic segment; distinct although incompletely separated from second thoracic segment. At least second and third thoracic segments pedigerous, segments either distinct or fused. Fourth and fifth thoracic segments fused with genital segment. Abdomen, if distinct, short, 1-segmented; frequently fused with genital segment; caudal rami minute. Antennule 3- to 7-segmented, antenna 2- or 3-segmented, terminal segment with claw. Mandible rodlike, denticulated distally. One pair of maxillae apparently lacking; maxillules or maxillae (probably maxillules) 2-parted or biramous (depending on degree of reduction), each part (if rudimentary) or ramus (if well developed) typically with 2 setae or spines. Maxilliped slender, terminal process typically bifurcate. First 2 thoracic leg pairs biramous, rami 1- or 2-segmented; third and fourth thoracic leg pairs rudimentary or absent; fifth pair absent.

Diagnosis of male.—Cephalothorax distinct from second thoracic segment, postcephalothoracic segments incompletely or completely fused. Abdomen, if distinct from genital segment, 1-segmented; caudal rami larger than in female, armed with spines or stiff setae. Appendages similar to those of female.

Hatschekia breviramus, new species

Figures 6, 7

Material.—Thirteen adult females from the external surface of *Mulloidichthys auriflamma* Forskål collected at Kauai, Hawaii. One

Figure 5.—*Anchistrotos moa*, new species, female, ventral view: *a*, oral region, right side showing labrum (lab), mandible (mdbl), maxillule (ma-1), maxilla, and paragnath (pg); *b*, antennule base (a-1) and postantennal process; *c*, projecting portion of maxilla; *d*, maxilliped. Thoracic legs, anterior view: *e*, right first; *f*, left second; *g*, left third; *h*, right fourth.

of these females has been designated as the holotype (USNM 112870), the others as paratypes (USNM 112869).

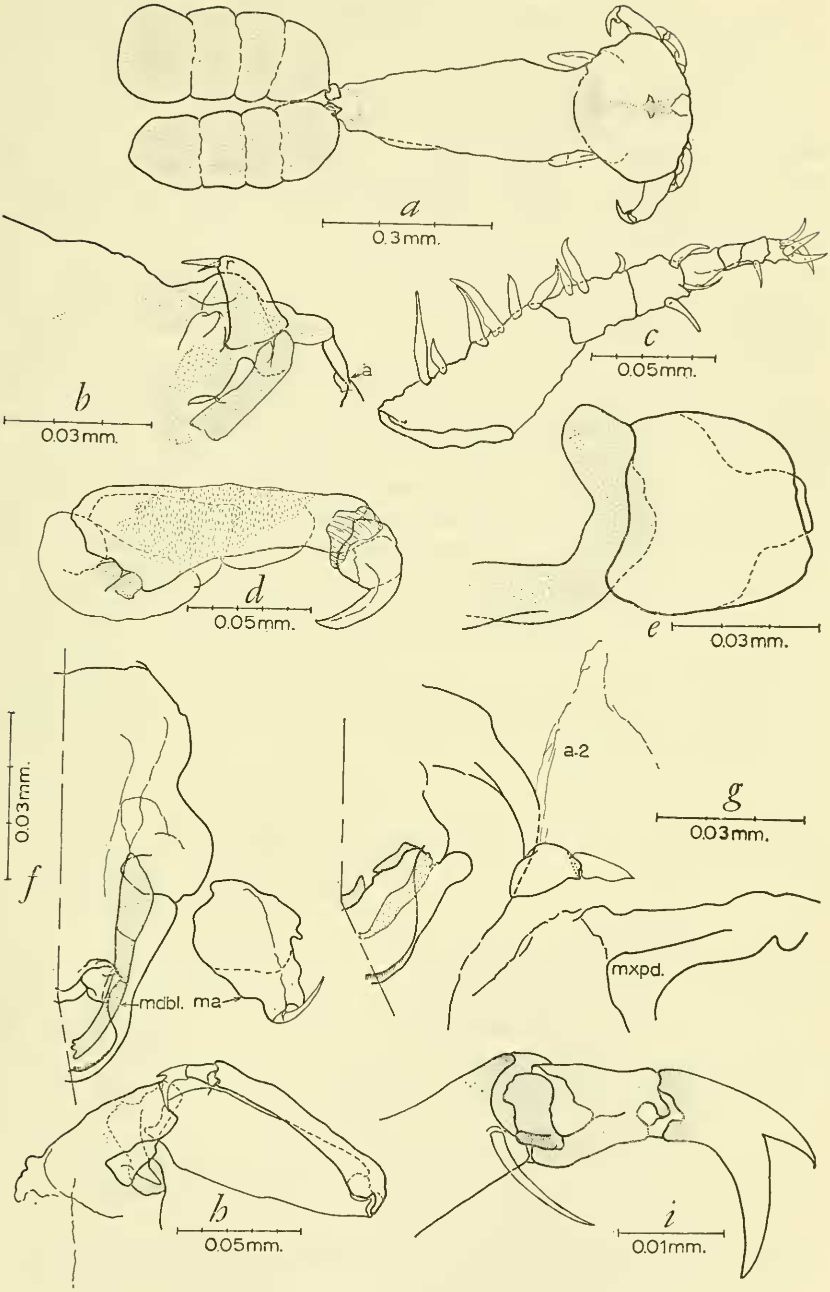
MEASUREMENTS.—(In mm) 10 females:

	mean	*range*
Greatest length of body	0. 67	0. 61–0. 73
Length of cephalothorax	0. 18	0. 16–0. 20
Width of cephalothorax	0. 29	0. 24–0. 33
Length of trunk	0. 56	0. 49–0. 62
Width of trunk	0. 23	0. 20–0. 25
Length of egg strings (5 strings)	0. 44	0. 36–0. 52

DESCRIPTION OF FEMALE.—Body (fig. 6*a*) divisible into two regions. Cephalothorax, including cephalon and maxilliped-bearing thoracic segment, forming first region, pedigerous segments and genital segment forming second. Cephalothorax of general ovoid shape, margins slightly irregular. Anterior dorsal region of cephalothorax heavily sclerotized, with cross-shaped region of sclerotization extending posteriorly on median dorsal surface to middle of cephalothorax although fine line of heavy sclerotization extending posteriorly to posterior-median dorsal surface. Second region composed of fused pedigerous and genital segments, constricted anteriorly into necklike connection with cephalothorax, constriction composed anteriorly of 2 dorsally fused pedigerous segments. Posterior two-thirds of second region tapered in some specimens to posterior end although shape variable, depending at least partially on number of eggs in genital segment. Posterior lateral and posterior ventral surfaces of second region irregular, knobby, knobs forming margin of oviducal openings and more apparent in ovigerous females. Posterior end rounded, projecting past oviducal openings in some specimens, bearing knoblike caudal rami on lateral ventral surface. Caudal rami (fig. 6*b*) small, each tipped by 2 small setules.

Antennule (fig. 6*c*) 6-segmented, strongly compressed. First segment with 6 irregular naked setae from ventral margin; second segment with 3 setae; third with 1 from ventral margin, 1 from distal, and third from dorsal surface; fourth segment naked; fifth with one seta from dorsal surface; sixth with 7 setules distally. Antenna (fig. 6*d*) 2- or 3-segmented, basalmost portion squat and irregular, segment-like but questionable, with several knoblike articulation surfaces received by proximal end of penultimate segment. Penultimate

FIGURE 6.—*Hatschekia breviramus*, new species, female: *a*, dorsal view; *b*, posterior region, left side showing caudal ramus (r) and anal indentation (a); *c*, right antennule, anterior view; *d*, left antenna, ventral view; *e*, membrane-like flap at base of antenna, ventral view; *f*, oral region, left side showing mouth cone, mandible (mdbl), and maxillule (ma); *g*, oral region showing mouth cone, mandible, maxilla?, antenna base (a-2), and maxilliped base (mxpd); *h*, maxilliped, ventral view; *i*, distal end of maxilliped, ventral view.


a
0.3 mm.
b
0.03 mm.
a
c
0.05 mm.
d
0.05 mm.
e
0.03 mm.
f
0.03 mm.
mdbl.
ma
g
a-2
0.03 mm.
mxpd.
h
0.05 mm.
i
0.01 mm.

226-321—67——2

segment elongate, broader proximally than distally, posterior and medial surfaces rugose. Distalmost segment short, subspherical, fused with clawlike terminal process, with very fine, hairlike accessory process (not shown in figure). Distinct flaplike projection present on heavily sclerotized cephalothoracic depression associated with antenna base (figs. 6*d, e*). Mandible (fig. 6*f*) appearing 3-parted although divisions indistinct; appendage rodlike, curved inward distally, distal surface composed of 3 small denticulations. Maxillule? platelike, projecting posteriorly and slightly ventrally from just lateral and posterior to mouth cone base, irregularly pointed distally, with single setule from distal surface.

Maxilliped (figs. 6*h, i*) 3- or 4-segmented, basalmost portion appearing as segment-like projection of cephalothorax. Projection concave distally, forming articulation surface for first distinct segment; segment slightly wider proximally than distally although proximal end tapered sharply to narrow proximal surface. Penultimate segment slender, proximal end with knob-shaped articulation surfaces, distal end with hairlike process. Distalmost segment short, heavily sclerotized, with bifurcate terminal process. Terminal process with both tines sharply pointed, innermost slightly less than twice the length of outermost.

First thoracic legs with 2-segmented exopodite, 1-segmented endopodite; second thoracic legs with 2-segmented exopodite and endopodite. Interpodal plates heavily sclerotized. For nature and armature of legs see figures 7*a, b*, and table 4.

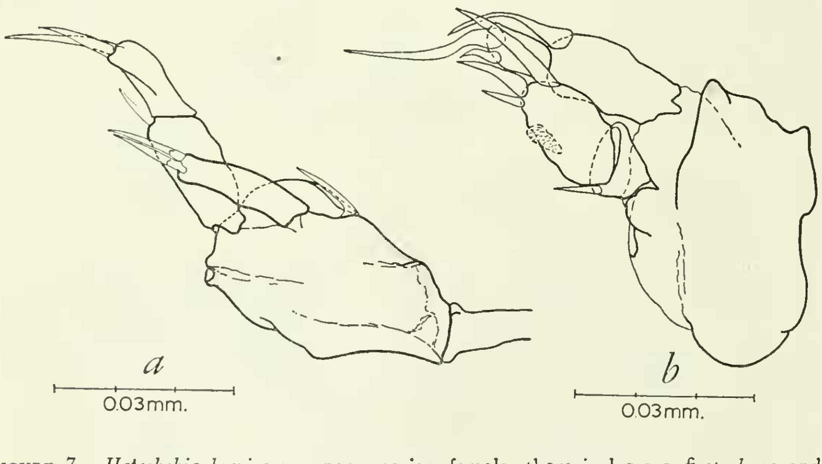


FIGURE 7.—*Hatschekia breviramus*, new species, female, thoracic legs: *a*, first; *b*, second.

DISCUSSION.—*Hatschekia breviramus* has characteristics which can be compared most closely to 5 other members of the genus:

1. *H. diodontis* Yamaguti, 1953: Similar in general body shape,

TABLE 4.—*Armature of thoracic legs I and II of the female of* Hatschekia breviramus, *new species*

Leg	Surface	Interpodal Plate	Protopodite	Exopodite		Endopodite	
				1	2	1	2
I	Outer			p′	p′	p′	
	Inner		p′		p′	p′	
II	Outer			P′	P′		P′
	Inner				p′	p′	2p′

distinct principally in nature of armature of antennule and thoracic legs.

2. *H. ostracii* Yamaguti, 1953: Similar in body shape and in the presence of the processes at the base of the antennae. *H. breviramus* differs from this species in having 6, not 7, segments in the antennule, the processes at the base of the antennae are not as large, the caudal rami are tipped by 2 setules, while there are 5 in *H. ostracii.* The endopodite of the first thoracic leg is 2-segmented in *H. ostracii* and 1-segmented in *H. breviramus; H. ostracii* also has a rudimentary third thoracic leg which is not present in *H. breviramus.*

3. *H. cadenati* Nunes-Ruivo, 1954: The thoracic leg armature is similar although the caudal rami of *H. cadenati,* in addition to other body parts, differ, having 5 setae and setules instead of 2 as in *H. breviramus.*

4. *H. bodiani* Nunes-Ruivo, 1954a: This species, like *H. ostracii* Yamaguti, 1953, has the projections at the base of the antennae that are present in *H. breviramus.* The maxilliped armature is also similar but the 2 species differ, most distinguishably in the armature of the caudal rami and thoracic legs.

5. *H. cluthae* (Scott, T., 1902): Similar in reduced armature of first thoracic leg, differs firstly in having 2-segmented endopodite on the first thoracic leg, secondly in having a more distinct abdomen, different armament on maxilliped, and general body shape.

The species name "*breviramus*" is derived from the Latin words "brevis" (short) and "ramus" (branch) and refers to the short caudal ramus.

Family Lernaeoceridae

Peniculus Nordmann, 1832

DIAGNOSIS.—See Lewis, 1964a.

Peniculus calamus? Nordmann

Peniculus calamus Nordmann, 1864, p. 5, no figures.
Peniculus calamus?—Lewis, 1964a, p. 233, fig. 24. [For bibliography, see Lewis 1964a.]

Hosts and distribution.—8 host records:

location	*hosts*	*reference*
Hawaiian Islands	Unknown	Nordmann, 1864
	Acanthurus dussumieri	Lewis, 1964a
	A. mata	
	A. olivaceus	
	A. triostegus sandvicensis	
	Ctenochaetus strigosus	
	Naso hexacanthus	
	N. unicornis	

Material.—One ovigerous female collected by D. Watson from the dorsal fin of *Pervagor spilosoma* (Lay and Bennett) from the Honolulu Aquarium.

Measurements.—Length from anterior end of head to posterior end of abdomen, excluding projecting second antennae, 2.89mm. Length of head 0.41mm; greatest width 0.28mm. Length of neck 0.22mm; greatest width 0.13mm. Greatest length of combined fourth pedigerous segment, genital segment, and abdomen 2.15mm. Length of egg strings 2.81 and 2.96mm.

Description.—See Lewis, 1964a.

Family Pennellidae

Pennella Oken, 1816

Diagnosis.—Female: Body heavily sclerotized, separable into cephalothorax, neck, and trunk (including abdomen). Cephalothorax suborbicular, consisting of cephalon and at least first thoracic segment; oral region at or near anterior end, surrounded by one or more types of papillae. Two to three heavily sclerotized horns present on posterior region of cephalothorax, at junction of cephalothorax and neck, or on anterior end of neck; horns of variable length and shape, usually projecting laterally or posterolaterally. Neck slender, cylindrical, distinct from cephalothorax due to size difference, usually continuous with trunk. Trunk elongate, cylindrical or slightly flattened dorsoventrally, with ventral indentation at genital openings and frequently with annulations along entire length. Abdomen forming posterior part of trunk, behind ventral indentation at genital openings, tapered posteriorly; posterior surface bilobed due to anal indentation, bearing minute caudal rami. Numerous branched or simple filiform processes arising from lateral or ventral and ventral lateral surface of abdomen, giving plumose appearance to posterior part of body. Egg strings long, frequently more than twice the length of body. Antennule 2- to 5-segmented, situated on dorsal surface of cephalothorax, behind antennae. Antennae chelate, 2- or 3-segmented (movable portion of claw designated as segment with terminal process). Mandibles of unknown nature; maxillules, maxillae, and maxillipeds present in late stages of development but absent in adult. Four pairs of thoracic legs present although poorly developed; first 2 pairs in close proximity on anterior ventral surface of trunk, third and fourth pairs removed variable distance behind second pair. First 2 pairs biramous, third pair typically uniramous, fourth pair probably always uniramous.

REMARKS.—The third and fourth thoracic legs are described as uniramous in the genus *Pennella* (Wilson, 1917; Leigh-Sharpe, 1928; Yamaguti, 1963). The third leg of one of the species here described is biramous. The difference may be interspecific in nature although the rami of any of the thoracic legs of the adult female are brittle and easily broken.

Pennella histiophori? Thomson, 1889

FIGURES 8, 9

Pennella histiophori Thomson, 1889, p. 368, pl. 38, fig. 2.—Bassett-Smith, 1899, p. 483.—Wilson, 1917, p. 113 (key).—Yamaguti, 1963, p. 208.
Pennella zeylanica? Kirtisinghe, 1932, p. 137, figs. 1–5.
Pennella instructa? Kirtisinghe, 1964, p. 110, fig. 153.

HOSTS AND DISTRIBUTION.—2 host records:

location	*hosts*	*reference*
New Zealand	*Histiophorus herschelli*	Thomson, 1889
Ceylon	*H. gladius*	Kirtisinghe, 1932, 1964

MATERIAL.—One complete, ovigerous female, 1 nonovigerous female without cephalothoracic papillae, and 1 incomplete female (trunk and part of neck missing), in addition to part of larval exuvium, collected by D. W. Strasburg from external surface of *Makaira audax* (Philippi) at 9°34′S, 136°45′W (USNM 112871).

REMARKS.—Although the host was collected far from the Hawaiian Islands, the wide distribution of the host and its common occurrence around Hawaii suggested the inclusion of the copepod in this treatise.

MEASUREMENTS.—(In mm) 2 females:

Total length (1 specimen)	172
Length of cephalothorax, excluding papillae	7, 7
Width of cephalothorax	8, 8
Length of neck	79, 51
Width of neck	3, 2
Length of trunk	86, 89
Width of trunk	6, 5
Approximate length of abdominal plumosities	25, 28
Length of attachment horns	(17, 10), (12, 12)
Length of egg string (1 string)	178

DESCRIPTION.—Female: Cephalothorax (figs. 8*a*, *b*) presumably consisting of cephalon and first thoracic segment although maxillipeds

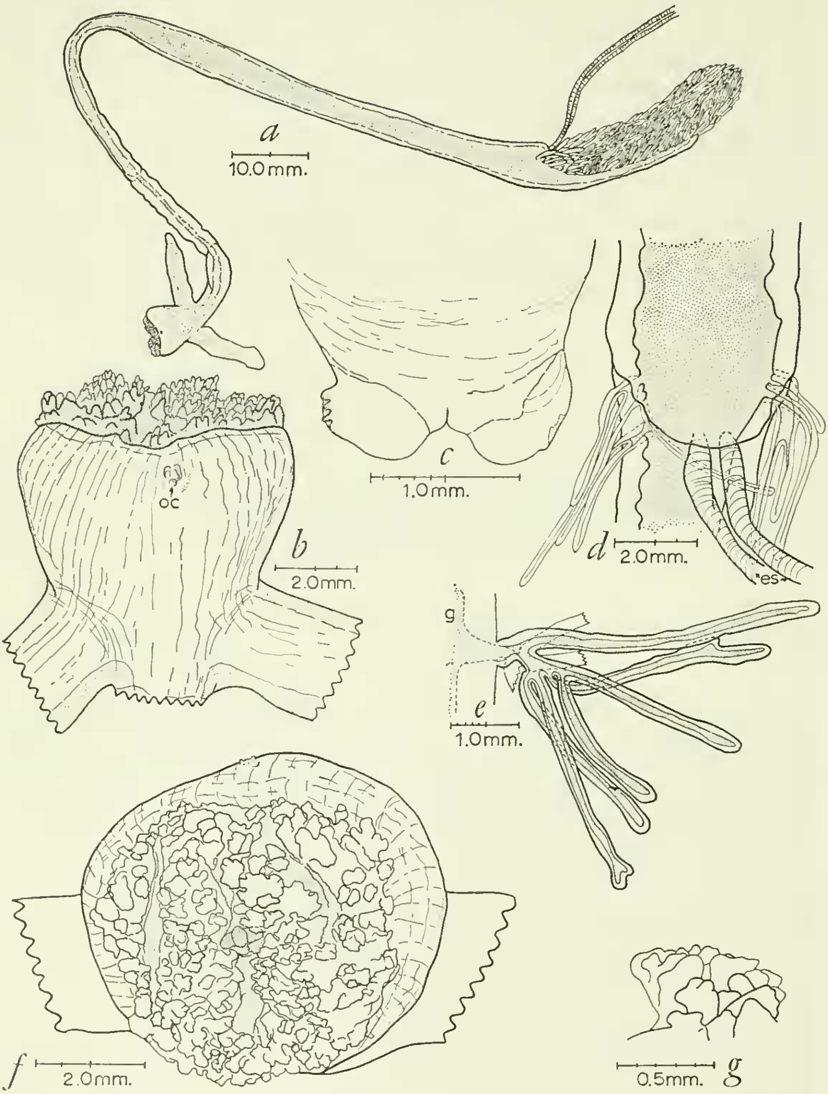


FIGURE 8.—*Pennella histiophori*? Thomson, 1889, female: *a*, dorsal view; *b*, cephalothorax, dorsal view (oc=ocular region); *c*, posterior end of abdomen, dorsal view showing caudal rami and anal indentation; *d*, genital region, ventral view showing egg strings (es); *e*, part of one filamentous posterior process showing connection with gut (g); *f*, cephalothorax, anterior view showing oral region; *g*, lateral view of some papillae in oral region.

not visible. Cephalothorax with 2 large, heavily sclerotized, dactyliform attachment processes on posterior lateral surface, processes projecting laterally and slightly posteriorly. Anterior end of cephalothorax with 4 adjacent rows of soft, irregular papillae (figs. 8*f*, *g*) running dorsoventrally, oral opening a distinct depression situated in middle of anterior end of cephalothorax, between inner 2 rows of papillae. Cephalothorax indistinctly separable from neck by indistinct, incomplete line of division extending between posterior ends of bases of attachment processes. Neck indistinctly separable into two parts by slight constriction of neck and alimentary tract; posterior end of neck separable from anterior end of trunk only by difference in width. Anterior part of neck with distinct constriction in figured specimen (fig. 8*a*) but constriction believed due to twisting of specimen. Trunk elongate, width varying little throughout length. Oviducal openings situated on indentation in posterior third of trunk (fig. 8*d*), at beginning of abdominal portion of trunk. Abdominal region tapered distally, bearing numerous ramified processes from lateral, ventral lateral, and ventral surfaces, with extension of alimentary tract running to blind termination at distal ends of processes (fig. 8*e*). Caudal rami knoblike, on distal lateral surfaces of abdomen, flanking V-shaped indentation at anal opening (fig. 8*c*), without setae; indication of armature present as 3 small irregularities of heavily sclerotized ramal surface.

Antennules and antennae situated on median dorsal surface, just posterior to frontal process region. Antennae anterior to antennules, articulating on heavily sclerotized ridge, ridge expanded medially, forming convex projection bearing small, indistinct remains of copepodite rostrum and small, heavily pigmented ocular region posterior to rostrum (fig. 9*a*). Antennule (fig. 9*b*) 3-segmented although articulating in doughnut-shaped structure distinct from cephalothoracic cuticle. First segment with 7 very lightly plumose setae on anterior surface, second segment more elongate than first, with approximately 11 very lightly plumose setae on anterior and anterior dorsal surface in addition to 1 elongate, aesthete-like structure on distal anterior surface. Third segment slightly narrower than second, with one aesthete-like structure from distal posterior surface, 7 naked processes from distal surface (1 of 7 aesthete-like). Antennae (fig. 9*c*) 3-segmented, first 2 segments broad, distalmost segment with clawlike terminal process. Inner proximal corner of first segment forming knoblike articulation surface, inner lateral margin of segment longer than outer margin; distal surface irregularly cup shaped, inner portion receiving inner proximal surface of second segment. Second segment with cup-shaped projection in inner distal surface, projection receiving distal end of terminal process of third segment when segment flexed, with large, irregular, heavily sclerotized projection of outer portion that forms articulation surface for third segment. Third segment small, proximal end irregular, heavily sclerotized; division between terminal process and segment indistinct; setalike accessory process present, distal to division between segment and terminal process.

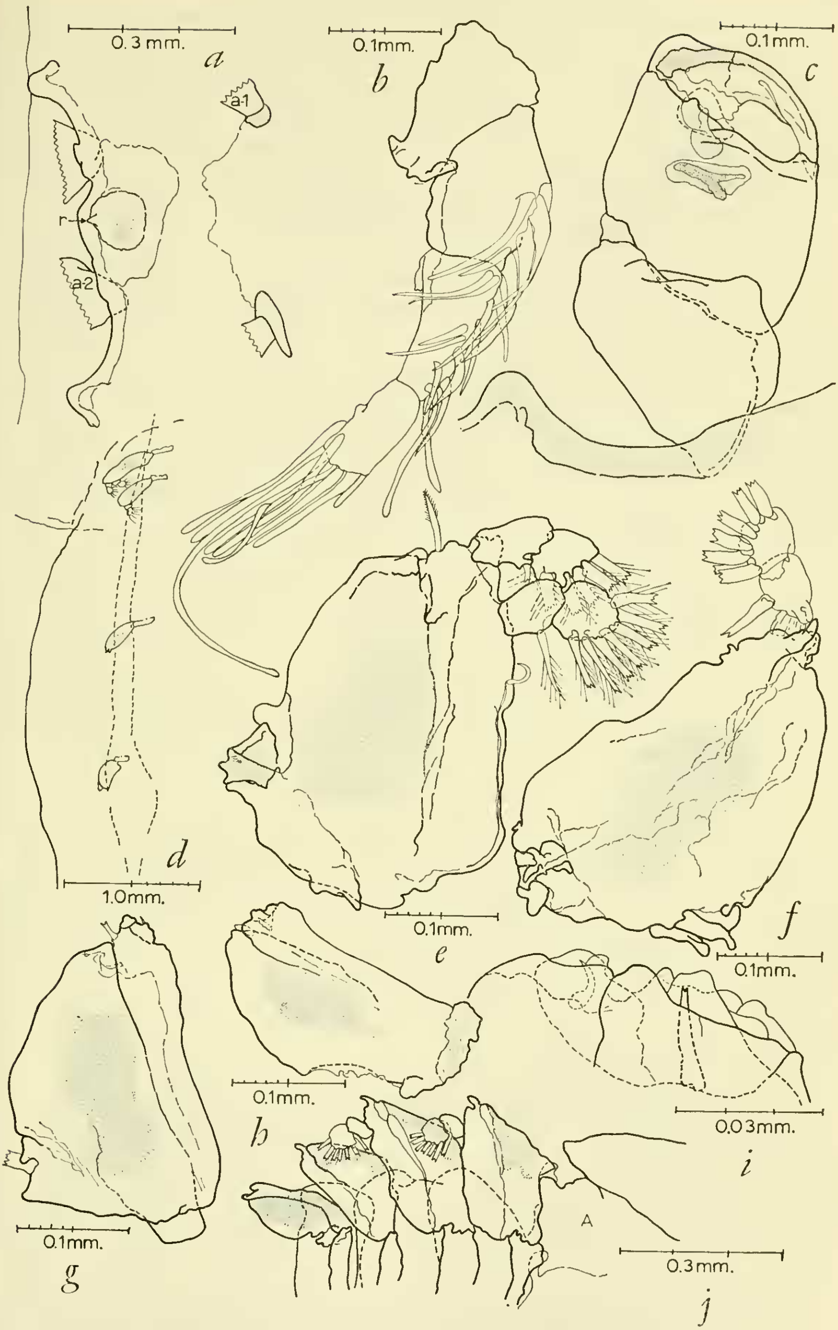
First 2 thoracic leg pairs in close proximity at anterior end of neck, third placed well behind second, and fourth behind third; ratio of proximity equals 1 (first to second leg) : 5.5 (second to third) : 5.5 (third to fourth) (fig. 9*d*). Protopodite of legs 1-segmented although appearing 2-parted, attached to well-developed interpodal plate. First thoracic leg biramous, rami 2-segmented, second leg appearing uniramous, both in adult female (fig. 9*f*) and larval exuvium (fig. 9*j*), although outline of leg and presence of exopodite on adult leg and endopodite on larval exuvium suggest loss of endopodite in adult specimen. Third and fourth thoracic legs without distinct indication of rami. Protopodite of all legs with dark brown to black pigment spot in alcohol-preserved specimens. For nature and armature of thoracic legs, see figures 9*e–j* and table 5.

TABLE 5.—*Armature of thoracic legs I–IV of the female of* Pennella histiophori? *Thomson, 1889*

Leg	Surface	Interpodal Plate	Protopodite	Exopodite		Endopodite	
				1	2	1	2
I	Outer		p		2P		3P
	Inner		p′	p	3P	P	4P
II	Outer				3P		
	Inner			P	3P		
III	Outer		p′				
	Inner						
IV	Outer						
	Inner		p′				

DISCUSSION.—The identification of the Hawaiian material as *Pennella histiophori*? Thomson, 1889, as well as the inclusion of the two names used by Kirtisinghe in the synonymy, is done with some question. The intraspecific variation present within the members of the genus, the wide distribution of many of the hosts of the genus, and the relative absence of definitive descriptions leave the

FIGURE 9.—*Pennella histiophori*? Thomson, 1889, female: *a*, ocular region, dorsal view showing rostrum (r), antennule base (a-1), and antenna base (a-2); *b*, antennule, dorsal view; *c*, antenna, dorsal view; *d*, pedigerous region of neck, ventral view. Right thoracic legs: *e*, first, posterior view; *f*, second (endopodite missing), anterior view; *g*, third (ramus or rami missing), posterior view; *h*, fourth (ramus missing), posterior view; *i*, distal end of protopodite of fourth, posterior view. Pedigerous region of larval exuvium: *j*, ventral view (A=anterior).


0.3 mm.
a
a-1
r
a-2
0.1mm.
b
0.1mm.
c
d
1.0mm.
0.1mm.
e
f
0.1mm.
0.1mm.
g
0.1mm.
h
0.03mm.
i
A
0.3mm.
j

taxonomy of the genus in confusion. Of all of the species, *P. instructa* Wilson is by far the most easily recognized, and the characteristic ramshorn-shaped attachment structures show little variation in the specimens present in the U.S. National Museum. Yamaguti's identification of Japanese pennellids from *Xiphias gladius* as *P. instructa* (1939b) may warrant some question although there is more evidence for his identification, from his figure (pl. 33, fig. 193) and from the host, than there is for the inclusion of other material in the species.

The original description of *P. histiophori* Thomson, 1889, indicates some differences between the type material and that here described. *P. histiophori* is figured as having a larger rounded protuberance on the ventral surface, between the bases of the attachment structures, the 4 pairs of thoracic legs appear to be more closely grouped, and the pedigerous area of the neck appears more swollen and distinct from the rest of the neck. The size of the minute ventral protuberance between the bases of the attachment structures is variable in the 3 specimens examined for this description, and there is variation in the size, shape, and position of numerous small irregularities on the cephalothorax. The grouping of the thoracic legs may be distinctive although Thomson's original figure is not clear enough to offer grounds for separation. The difference in the size of the pedigerous region of the neck and the distinction of this region from the rest of the neck may, based on an examination of the variation in some of the other members of the genus, be due to intraspecific variation.

Pennella species

Material.—One complete and 1 incomplete (abdomen missing) nonovigerous female (USNM 112872) from the external surface of *Remoropsis brachypterus* (Solander) collected by the USFWS from the stomach of a yellow-fin tuna, *Neothunnus macropterus* (Schlegel), captured off Hawaii.

Measurements.—(In mm) females:

Greatest length of body (N=1)	35.85
Length of cephalothorax (N=2)	4.00, 3.75
Width of cephalothorax (N=2)	2.85, 3.00
Length of neck (N=2)	10.88, 12.75
Width of neck (N=2)	1.65, 1.35
Length of trunk (N=1)	21.00
Width of trunk (N=1)	1.50
Approximate length of abdominal plumosities (N=1)	7.13
Length of attachment structures (N=2)	(2.25, 2.25), (3.15, 4.05)

Description.—Cephalothorax (figs. 10*a*, *b*) presumably consisting of cephalon and first thoracic segment although maxillipeds not discernible. Pair of long, dactyliform attachment processes present immediately posterior to cephalothorax. Cephalothorax with 2 types

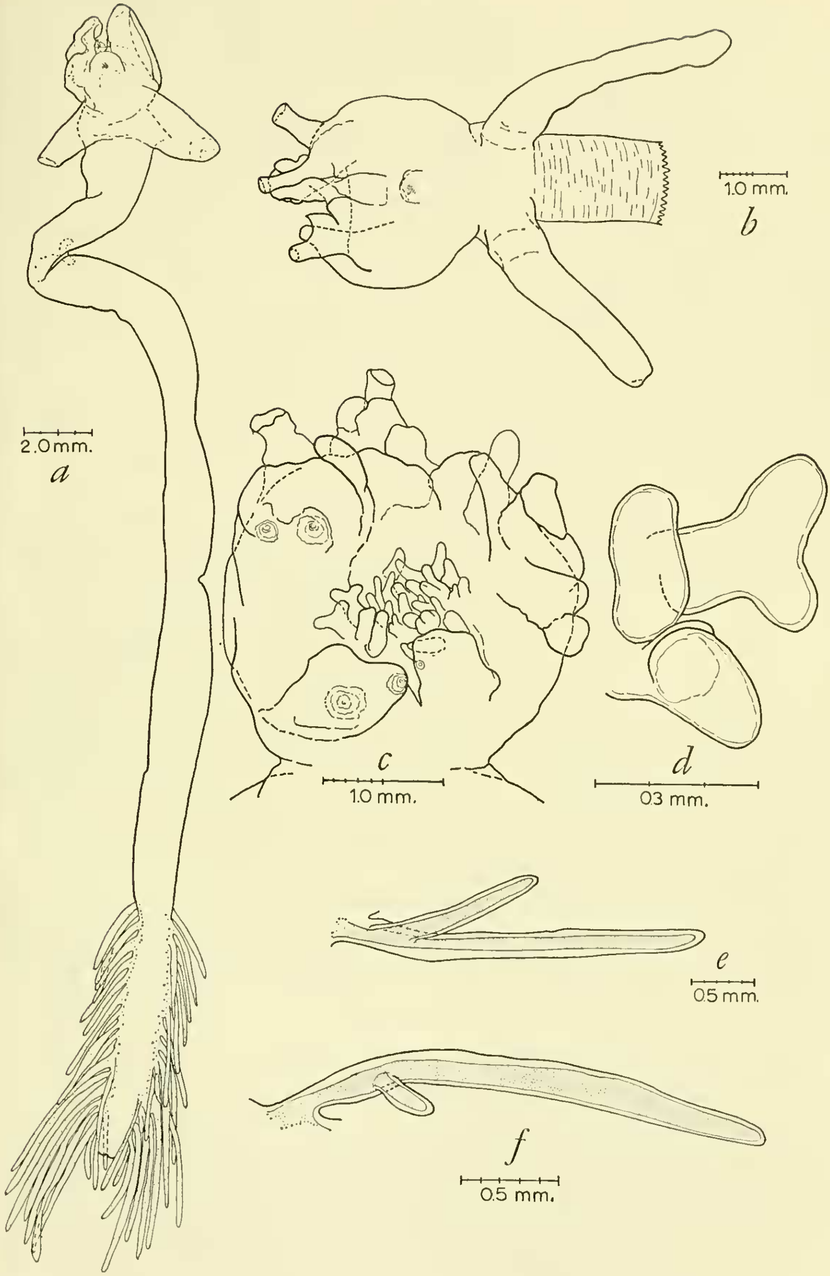


FIGURE 10.—*Pennella* species, female: *a*, dorsal view (specimen 1); *b*, anterior trunk region and cephalothorax, dorsal view (spec. 2); *c*, cephalothorax, ventral view showing large peripheral and smaller oral papillae (spec. 2); *d*, three oral papillae (spec. 2); *e*, *f*, abdominal processes.

of soft protuberances (figs. 10*c*, *d*): first large, irregularly shaped, clustered on anterior end but extending posterolaterally to mouth region, pair also present on posteroventral surface, somewhat isolated from other large protuberances; second type also irregular, smaller, clustered around oral orifice. Neck indistinctly separable from cephalothorax, width varying little throughout length, separated from trunk by slight constriction. Trunk width varying little throughout length, with narrow, V-shaped, heavily sclerotized indentation just posterior to minute, lappet-shaped spermatophores adjacent to oviducal openings (fig. 11*b*). Abdominal portion of trunk tapered distally, with numerous rodlike uniramous or biramous processes from lateral surface (figs. 10*e*, *f*), each with extension of alimentary tract running to blind termination at distal end. Distal end of abdomen bilobed, anal opening at median indentation, each lobe with minute caudal ramus. Caudal rami (fig. 11*a*) consisting of 5 naked setules, 3 on irregular knob, 2 on abdominal surface adjacent to knob.

Dorsal surface of cephalothorax with narrow, U-shaped region of heavy sclerotization anteriorly, apex of U directed anteriorly, with irregular suborbicular projections; ends of U with minute, spikelike projections. Antennal articulation surfaces present on region, just lateral to apex. Antennules not present although indication of articulation surface present lateral and slightly posterior to antennal base. Antennae (fig. 11*d*) 3-segmented, segments 1 and 2 broad, segment 3 and associated terminal process forming clawlike structure. Outer proximal surface of first segment extending as knoblike articulation surface, inner lateral surface approximately three-fourths the length of outer, with knoblike heavily sclerotized region distally. Second segment slightly more than half the length of first, inner distal and lateral surfaces forming spikelike projection, outer distal surface irregular, forming articulation surface for third segment. Third segment short, continuous with terminal process; small, lappet-shaped accessory process present on proximal surface of fused segment and terminal process.

First 2 thoracic leg pairs in close proximity at anterior end of trunk, third somewhat distant from second and fourth from third. Ratio of proximity of thoracic leg pairs equals 1 (first to second leg): 2 (second to third): 1.5 (third to fourth). Protopodites of all 4 legs 1-segmented although appearing 2-parted, all attached to distinct interpodal plate. Thoracic legs I–III biramous (exopodite of leg II lost in one specimen), rami 2-segmented; fourth thoracic leg probably uniramous, ramus 2-segmented. Protopodite of all 4 legs with dark brown to black pigment spot. Nature and armature of thoracic legs given in figures 11*e*–*h* and table 6. Some errors are believed incorporated into both the figures and the table because of the method

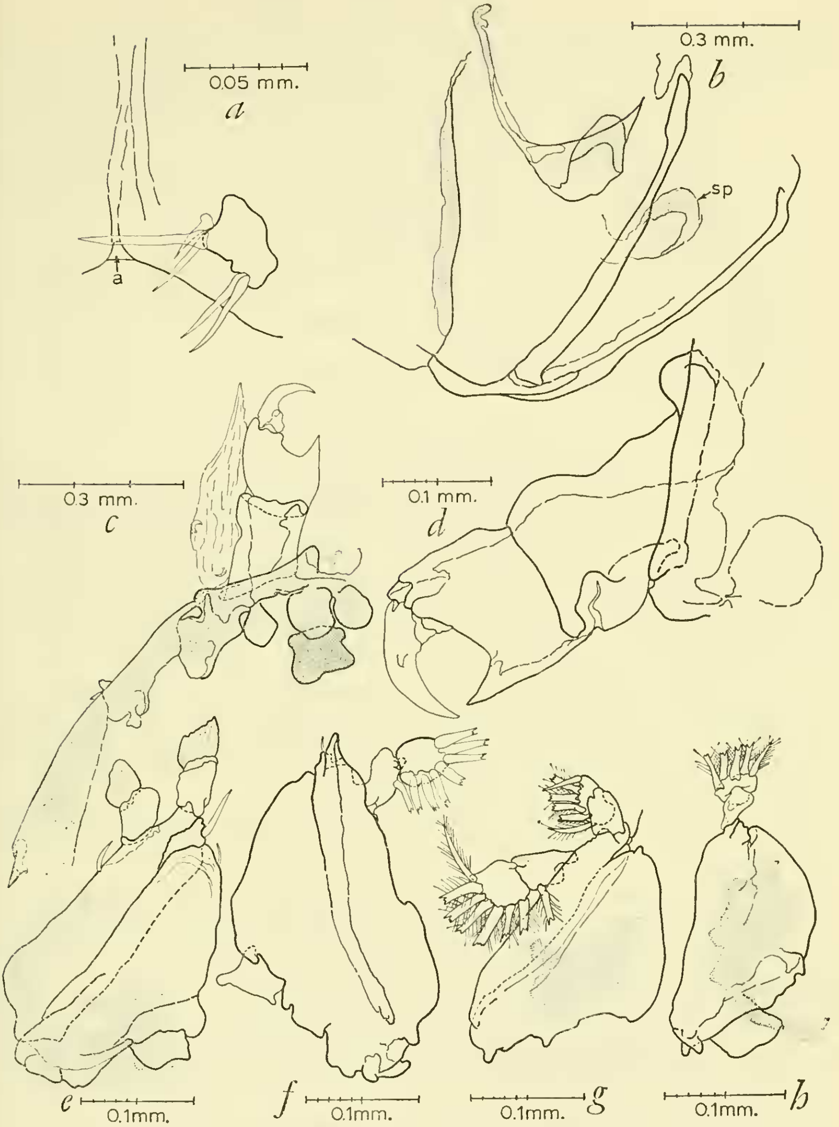


FIGURE 11.—*Pennella* species, female: *a*, caudal ramus, dorsal view (a = anus); *b*, ventral portion of genital region, lateral view (sp = spermatophore); *c*, ocular region of cephalon, dorsal view showing antenna, heavily sclerotized spine, and ridge; *d*, right antenna, dorsal view. Thoracic legs, anterior view: *e*, right first; *f*, left second (exopodite missing); *g*, right third; *h*, right fourth.

of collection of the specimens and the brittle nature of the thoracic legs of adult females of the genus.

Table 6.—*Armature of thoracic legs I–IV of the female of* Pennella *species*

Leg	Surface	Interpodal Plate	Protopodite	Exopodite		Endopodite	
				1	2	1	2
I	Outer		s, p′				
	Inner		p′	?	5P?	?	6P?
II	Outer		s				
	Inner			?	6P?	P	7P
III	Outer		s				
	Inner				5P, p	P	6P, p
IV	Outer						
	Inner				4P, p		

Discussion.—Although much of the body and many of the appendages and processes of the 2 specimens were apparently undamaged by the ingestion and partial digestion of the host, there is some evidence of damage (e.g., thoracic legs). For this reason it is felt that specimens in better condition are essential before a name is given to this species. The specimens, however, have characteristics similar to several species of the genus:

1. *Pennella selaris* Kirtisinghe, 1964: Similar in cephalothorax, orientation of abdominal plumosities. Differs from *Pennella* species in possessing shorter and unbranched abdominal plumosities and in the arrangement of the thoracic legs.

2. *P. biloba* Kirtisinghe, 1932: Cephalothorax and general body shape similar. Abdominal processes unbranched in *P. biloba,* branched in *P.* sp.

3. *P. diodontis* Oken, 1816: Arrangement of cephalothoracic papillae and abdominal processes similar. Abdominal processes unbranched in *P. diodontis.*

4. *P. exocoeti* (Holten, 1802): Arrangement and branching of abdominal processes similar. Cephalothorax not bilobed in *P. exocoeti,* nature and arrangement of cephalothoracic papillae appear different.

5. *P. remorae* Murray, 1856: Abdominal processes in 2 rows, as in *P.* sp. Cephalothorax of *P. remorae* not lobed, with 3 horns (characteristic variable), anterior end cuplike (not depressed in *P.* sp.), neck more distinct, abdominal processes more ramified.

Family Anthosomatidae

Norion Nordmann, 1864

Diagnosis.—See Lewis, 1964a.

Norion expansus Nordmann

Norion expansus Nordmann, 1864, p. 489, pl. 6.—Lewis, 1964a, p. 226, figs. 22–23. [For bibliography, see Lewis, 1964a.]

HOSTS AND DISTRIBUTION.—3 host records:

location	*hosts*	*reference*
Hawaiian Islands	unknown	Nordmann, 1864
	Naso lituratus	
	N. hexacanthus	Lewis, 1964a

DESCRIPTION.—See Lewis, 1964a.

Family Pandaridae

Nesippus Heller, 1865

DIAGNOSIS.—See Lewis, 1964a.

Nesippus costatus? Wilson

Nesippus costatus Wilson, 1924, p. 213, pl. 20.
Nesippus costatus?—Lewis, 1964a, p. 211, figs. 19–21.

HOSTS AND DISTRIBUTION.—7+ host records:

location	*hosts*	*reference*
Galapagos Islands	"A nine-foot shark"	Wilson, 1924
Hawaiian Islands	Cysts on:	Lewis, 1964a
	Acanthurus triostegus sandvicensis	
	A. nigroris	
	A. xanthopterus	
	Ctenochaetus strigosus	
	Diodon holocanthus	
	Scarus species	
	labrids	
	pomacentrids	
	zanclids	

MATERIAL.—One immature male (early encysted stage of Lewis, 1964a) in cyst on dorsal fin of *Seriola dumerilli* (Risso) from Honolulu Aquarium. Cysts with exuviae (no animal) or partially resorbed cysts found on specimens of *Aulostomus chinensis* (Linnaeus), *Chaetodon miliaris* Quoy and Gaimard, and *Myripristis pralinius* Cuvier and Valenciennes.

MEASUREMENTS.—Length of body, excluding caudal setae, 1.96mm. Length of cephalothorax, including frontal region, 1.39mm; width 1.55mm. Length of genital segment 0.34mm; width 0.47mm. Length of caudal rami 0.22mm.

DESCRIPTION.—See Lewis, 1964a.

Family Euryphoridae

Euryphorus Milne-Edwards, 1840

DIAGNOSIS.—Cephalothorax suborbicular, consisting of cephalon and first 4 thoracic segments, frontal region well defined. Free fourth pedigerous segment with alae (larger in female than in male). Female genital segment large, suborbicular, with pair of posterior lobes; male genital segment longer than wide, of variable shape but lateral margins generally parallel, without posterior lobes. Abdomen 2- or 3-segmented, female first segment elongate, with pair of large, lamellate processes extending posteriorly past caudal rami, remaining segment or segments without lamellate processes; male first segment shorter than in female, lamellate processes thicker and smaller, extending posteriorly only to region of second abdominal segment, remaining segment or segments as in female. Caudal rami similar to those of other euryphorids. Antennule 2-segmented; antenna 3-segmented, prehensile, male with enlarged secondary spines. Mandible rod shaped, denticulated distally; maxillule nodular, tipped by 3 setae; maxillae 2-segmented. Postantennal process consisting of 2 nodules with hairlike processes; postoral process spinelike. Maxilliped 2-segmented, prehensile, with 2 subtriangular protuberances on first segment. Sternal furca with divergent tines in female, almost parallel tines in male; furca-like processes present posterior to interpodal plate of first and second thoracic legs. Thoracic legs I–IV biramous, ramal segment count 2–2, 3–3, 3–3, 3–2, fifth legs setiform.

Euryphorus nordmanni Milne-Edwards

Figures 12–15

Euryphorus nordmanni Milne-Edwards, 1840, p. 462, pl. 39, fig. 1.—Kner, 1859, p. 268, figs. 1–3.—Bassett-Smith, 1899, p. 461.—Kirtisinghe, 1937, p. 445, figs 74–87.—Yamaguti, 1963, p. 98.

Euryphorus nympha Steenstrup and Lütken, 1861, p. 365, pl. 6, fig. 12.—Heller, 1868, p. 198.—Bassett-Smith, 1899, p. 461.—Wilson, 1913, p. 225.—Shiino, 1954b, p. 284, figs. 5–6; 1959a, p. 350; 1959b, p. 20, fig. 9.—Ho, 1963, p. 83, figs. 1–3.—Yamaguti, 1963, p. 99.—Kirtisinghe, 1964, p. 88, fig. 104.

Euryphorus coryphaenae Krøyer, 1863, p. 161, pl. 10, fig. 4a–h.—Wilson, 1913, p. 225.—Yamaguti, 1936b, p. 1, pl. 1, figs. 1–17.—Bonnet, 1948, p. 7.—Causey, 1953a, pp. 7, 9; 1953b, p. 11; 1955, p. 6.

Remarks.—See discussion section, following description, for discussion of synonymy.

Hosts and distribution.—10 host records:

locality	*host*	*reference*
"Des mers d'Asie"	Unknown	Milne-Edwards, 1840
Western Pacific	*Coryphaena hippurus*	Yamaguti, 1936b
	Neothynnus macropterus	Shiino, 1954b
Hawaii	*Coryphaena hippurus*	Bonnet, 1948
Indian Ocean	"Seefischen"	Kner, 1859
	Coryphaena hippurus	
	C. h. equisetis	Kirtisinghe, 1937

ocality	host	reference
Tropical, subtropical Atlantic	*Lampugus punctulatus*	Steenstrup and Lütken, 1861
	Coryphaena hippurus	Krøyer, 1863
Gulf of Mexico	*Coryphaena hippurus*	Causey, 1953a

Material.—Two females and 2 males (USNM 112873) from the gill cavity of *Coryphaena hippurus* Linnaeus taken by trolling 120 miles south of Oahu, Hawaii (USFWS). Two females and 2 males (USNM 112874) from the gill cavity of *C. hippurus* Linnaeus taken by trolling at 15°N, 115°W (USFWS). One female and one male (USNM 112875) from the gill cavity and buccal cavity of *C. hippurus* Linnaeus taken by trolling, 130 miles south of Niihau, Hawaii (USFWS).

Measurements.—(In mm) 5 females and 5 males:

	female		male	
	mean	range	mean	range
Length of body, excluding caudal setae	9. 65	7. 80–10. 50	5. 84	5. 33–6. 45
Length of cephalothorax, including frontal region	2. 77	2. 63– 2. 96	2. 46	2. 37–2. 52
Width of cephalothorax	2. 75	2. 63– 2. 81	2. 35	2. 26–2. 52
Length of genital segment, excluding genital flap	1. 98	1. 52– 2. 22	1. 27	1. 15–1. 44
Width of genital segment	2. 55	1. 85– 2. 85	1. 13	1. 04–1. 18
Length of abdomen	4. 31	2. 70– 5. 10	1. 50	1. 43–1. 58
Length of alae	0. 78	0. 74– 0. 83	0. 55	0. 45–0. 61
Length of genital flap	0. 67	0. 61– 0. 72		
Length of abdominal projection	4. 85	2. 70– 6. 08	1. 10	0. 98–1. 28
Length of caudal rami	0. 46	0. 43– 0. 49	0. 34	0. 31–0. 36
Length of egg string (1 string)		9. 23		

Description.—Female cephalothorax (fig. 12*a*) ovoid, consisting of cephalon, maxilliped-bearing, and first 3 pedigerous segments. Frontal region broad, approximately one-tenth the length of cephalothorax, distinctly separable from rest of cephalothorax; anterior edge with fine membrane. Lateral cephalothoracic margins flatly convex except for sharp median indentation, margin bearing narrow membranous flange. Posterior lateral cephalothoracic regions sharply rounded, extending posteriorly slightly past median cephalothoracic region. Posterior sinuses distinct (fig. 12*c*), U-shaped, with narrow but distinct flange extending medially from outer margin and bearing fine membrane. Dorsal cephalothoracic grooves forming irregular H, posterior longitudinal grooves of H formed by junction of posterior lateral cephalothoracic region and median cephalothoracic region; crossbar irregular, in posterior third of body; anterior longitudinal grooves extending anteriorly to just lateral to 3-parted ocular region. Ocular region consisting of 2 ovoid contiguous pigmented bodies, each with lens, and smaller pigmented area between posterior

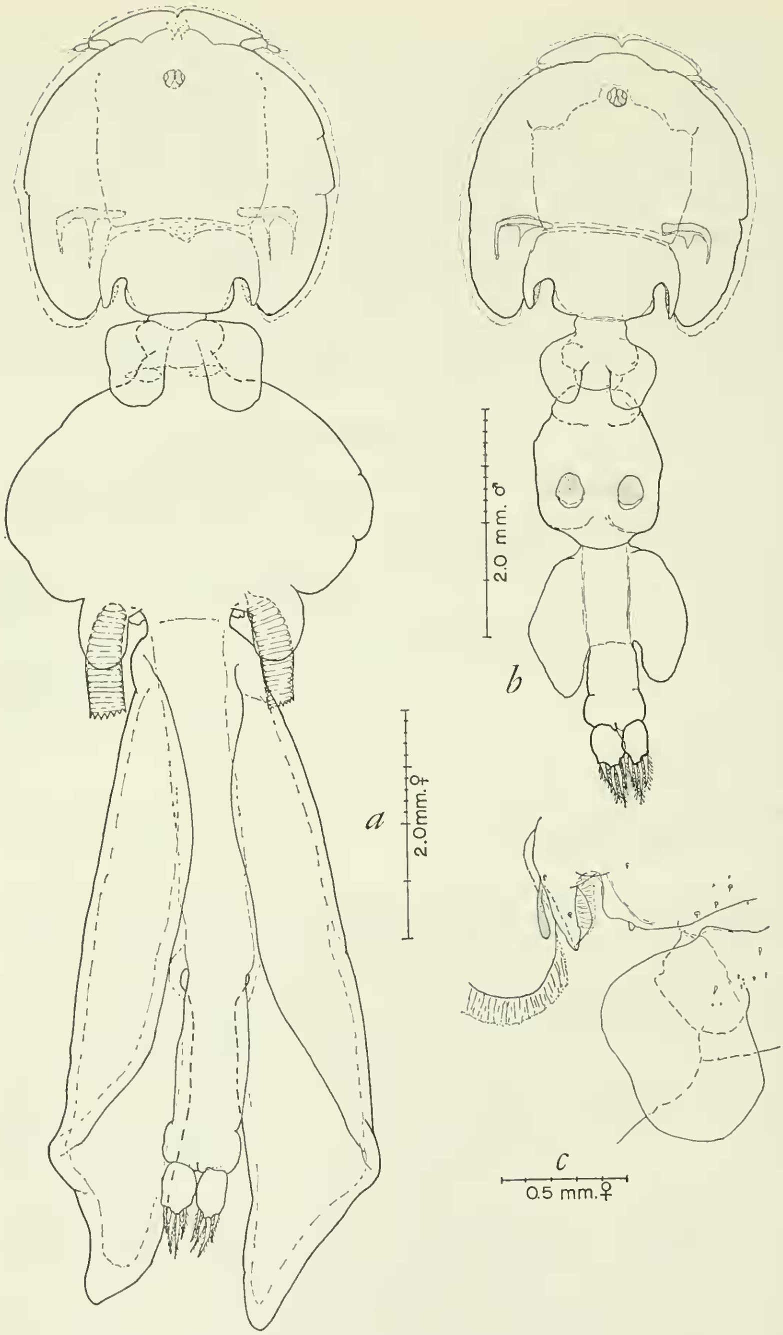


FIGURE 12.—*Euryphorus nordmanni* Milne-Edwards, 1840, dorsal view: *a*, female; *b*, male; *c*, female posterior cephalothoracic sinus and free fourth pedigerous segment, including ala.

regions of ovoid bodies. Posterior median cephalothoracic region with several spinules dorsally.

Female free fourth pedigerous segment distinct from cephalothorax and genital segment, greatest length, excluding alae, slightly less than one-fifth the length of cephalothorax. Segment broadest medially, with short, necklike region anteriorly. Alae small, subrectangular although shape variable, arising from broad medial portion of segment, extending posteriorly over part of anterior dorsal surface of genital segment. Alae not connected as indicated by Shiino (1954b). Median dorsal surface of segment with several spinules.

Female genital segment (fig. 13*a*) broad, lateral margins irregular, lateral surface projecting laterally past ventrally swollen medial region. Anterior end of segment narrow, bearing pair of heavily sclerotized, leglike plates (fig. 13*e*) ventrally, each with fimbriated edge. Plates connected by ridge of heavy sclerotization similar to interpodal plates of fourth thoracic legs. Homologies of structure unknown, no comparable structure on male or on members of genus *Elytrophora*, which appears closely related to *Euryphorus*. Posterior surface of genital segment irregular, with pair of knobby projections ventrally, in region of oviducal openings and with pair of small, lappet-shaped projections dorsally, overlapping egg strings. Female fifth legs (fig. 13*c*) situated ventral and lateral to base of lappet-shaped projections, consisting of 2 nodules, first bearing single plumose setule, second bearing 3 plumose setules.

Female abdomen (fig. 12*a*) elongate, distinctly separable from genital segment ventrally, indistinctly separable dorsally. Segmentation of adult female obscured although suggestion of 3 segments. First segment approximately 65 percent of total length, slender, bearing pair of large, curled, or uncurled flaps projecting posteriorly past caudal rami. Division between first and second segments suggested only by end of base of flaps although division complete in male. Second segment elongate, forming 25 percent of abdomen length. Division between second and third "segments" indicated by cuticular constriction, third "segment" short, approximately 9 percent of abdomen length, median posterior surface projecting slightly in biconvex anal region. Caudal rami (fig. 13*f*) ovate, margins irregular, distal inner surface plumose; distal surface with 2 large plumose setae from tubercular projection, 2 additional large setae, one on either side of projection, and 2 plumose setules.

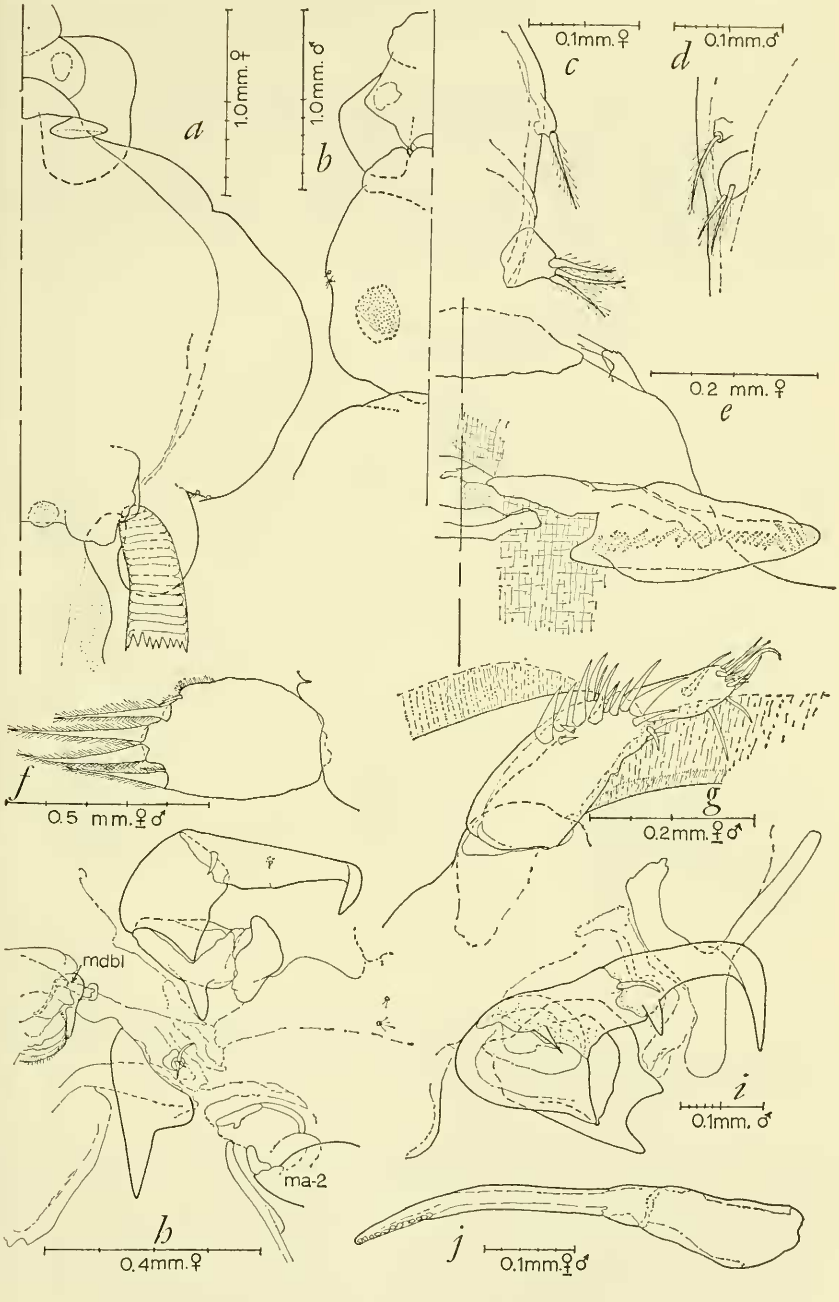
Male cephalothorax (fig. 12*b*) similar to that of female although indentation of lateral margin less distinct and posterior median region with fewer dorsal spinules. Free fourth pedigerous segment similar, alae smaller, of general ovoid shape. Genital segment (fig.

13*b*) distinct from fourth pedigerous segment, shape irregularly ovoid. Segment appearing 2-parted dorsally, with indication of break ventrally; anterior fourth of segment (in region of ventrally projecting plates in female) with distinct line of division on lateral dorsal surface. Fifth legs (fig.13*d*) situated on lateral ventral surface in middle of segment, consisting of 2 nodules, anteriormost with single plumose setule, posteriormost with 3 plumose setules. Abdomen distinct from genital segment, elongate, segmentation more distinct than in female. First segment approximately 53 percent of abdomen length, with pair of large flaps (smaller than those of female although thicker) extending posteriorly to end of second segment. Second segment approximately 27 percent of abdomen length, cylindrical; third "segment" approximately 20 percent of abdomen length, similar in shape to that of female. Caudal rami as in female.

Female antennule (fig. 13*g*) 2-segmented, attached to lateral-anterior ventral surface of cephalothorax and posterior-lateral ventral surface of frontal region. First segment slightly more than twice the length of second, with approximately 15 naked or lightly plumose setules. Second segment cylindrical, with single naked setule from median dorsal surface, second from median posterior surface, approximately 11 from distal region. Male antennule similar to that of female although sclerotization of first segment irregular, giving pseudosegmented appearance (Shiino's "2 false joints," 1954b, p. 288). Female antenna (fig. 13*h*) 3-segmented, attached posterior and medial to antennule base. First segment short, irregular, with posteriorly projecting spike from posterior surface. Second segment strongly developed, without any major irregularities. Third segment and terminal process clawlike, segment separable from terminal process only by indistinct break in sclerotization, with setalike accessory process from proximal posterior surface, second from distal posterior surface. Male antenna (fig. 13*i*) similar to that of female except spikelike projection of first segment smaller, third segment distinctly separable from terminal process, terminal process with spikelike projection from proximal posterior surface.

Female and male mandible (figs. 13*h*, *j*) 3-parted, rodlike. First part broad proximally, tapered distally; second part short, slightly less than half the length of first, tapered. Third part elongate, slightly

FIGURE 13.—*Euryphorus nordmanni* Milne-Edwards, 1840; ventral view: *a*, female free fourth pedigerous segment, genital segment (with projecting plates at anterior end), and anterior end of abdomen; b, male, same; *c*, female fifth leg; *d*, male fifth leg; *e*, anterior end of female genital segment showing projecting plates; *f*, caudal ramus; *g*, left antennule; *h*, female oral region, left side showing antenna, postantennal process, mouth cone, mandible (mdbl), maxillule, postoral process, maxilla base (ma–2), and postoral V-shaped ridge; *i*, male left antenna; *j*, mandible.


a
1.0mm.♀
1.0mm.♂
b
0.1mm.♀
c
0.1mm.♂
d
0.2 mm.♀
e
f
0.5 mm.♀♂
g
0.2mm.♀♂
mdbl
ma-2
h
0.4mm.♀
i
0.1mm.♂
j
0.1mm.♀♂

less than twice the length of first, distal region curved inward slightly, with 12 denticulations on inner surface. Female and male postantennal process (fig. 13*h*) evidenced only by pair of nodules lateral to antenna base, each with several hairlike processes. Female and male postoral process (fig. 13*h*) spikelike, with broad base, tapered to sharp distal end, outer margin sharply indented medially. Female and male maxillule (fig. 13*h*) nodular, with 3 setule-like processes distally. V-shaped heavily sclerotized ridge present posterior to

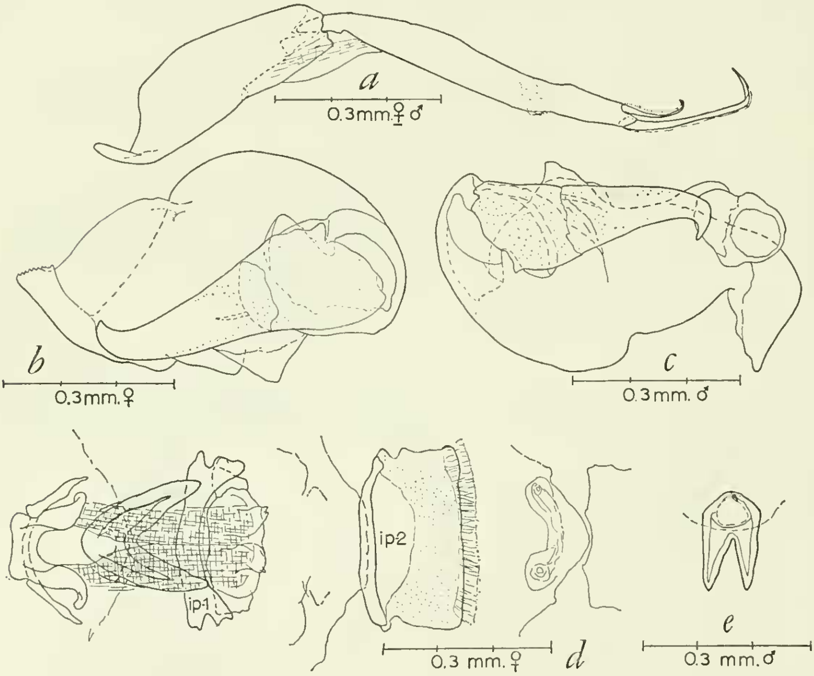


FIGURE 14.—*Euryphorus nordmanni* Milne-Edwards, 1840, ventral view: *a*, left maxilla; *b*, female left maxilliped; *c*, male, same; *d*, female sternal furca, interpodal plates of first and second thoracic legs (ip-1, 2), and furcal modification of platelike projections behind interpodal plates; *e*, male sternal furca.

mouth cone (fig. 13*h*), in same region as adhesion pads of pandarids, some euryphorids and some caligids. Female and male maxilla (fig. 14*a*) 2-segmented, situated lateral and slightly posterior to postoral process, arising from padlike projection. First segment approximately three-fourths the length of second; second segment elongate, broadest medially, with membrane extending along median posterior surface. Distal end of second segment with 2 setalike processes, innermost slightly less than twice the length of outermost, with fine membrane along inner margin; outermost process with frilled membrane along outer margin.

Female maxilliped (fig. 14*b*) 2-segmented, situated posterior and medial to maxilla base, on ovoid, padlike projection. First segment strongly developed, irregular, narrow proximally, broad medially, with 2 subtriangular projections from inner surface. Second segment and terminal process clawlike, segment short, distinct from terminal process, with setule-like accessory process from distal inner surface. Male maxilliped (fig. 14*c*) similar to that of female except with additional, knoblike projection on proximal inner surface of first segment. Female sternal furca (fig. 14*d*) V-shaped, tines bluntly pointed. Male sternal furca (fig. 14*e*) with V-shaped sinus but lateral margins almost parallel, tines not diverging as in female.

For nature of thoracic legs and armature, see figure 15 and table 7. Flabby, bifurcate projection present just posterior to interpodal plate of first thoracic leg, similar though less distinct projection present posterior to second thoracic legs.

TABLE 7.—*Armature of thoracic legs I–IV of the female and male of* Euryphorus nordmanni *Milne-Edwards, 1840*

Leg	Surface	Interpodal Plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer		p		h	d,dH,2dH, P			C,P	
	Inner		p		c	3P			2P	
II	Outer	m		m,p	m,d,fmH	fmH	2fmH,Q,2P	c	c	3P
	Inner		s,P	m,s	c,P	c,P	3P	P	c,2P	3P
III*	Outer	m	m,P		d,H	d,h	3h,2P	c	c	3P
	Inner		2s,r†,P,m,3s		c,P	c,P	3P	P	c,2P	P
IV*	Outer		p		d,fmH	d,fmH	d,fmH,d, 2fmH	c	c,2P	
	Inner		fm			P	4P	P	c,2P	

*Numerous hairlike projections (s) in middle of segment, not included in table.
†Roughened area (in this case by denticulations).

DISCUSSION.—The synonymyzing of *Euryphorus coryphaenae* Krøyer with *E. nympha* Steenstrup and Lütken was first done by Bassett-Smith (1899) although no reasons were given. Wilson (1913) suggested that the two were synonymous but it was not until Shiino (1954b) that Bassett-Smith's belief was reiterated. Shiino did not have Krøyer's original description of *E. coryphaenae* so did not give an analysis of the two species.

In a comparison of *E. nympha* and *E. coryphaenae*, the major differences appear, from the publications, to be in the sternal furca (that of *E. nympha* having more widely spaced tines) and in the armature and its position on the first thoracic leg (*E. coryphaenac* figured as having

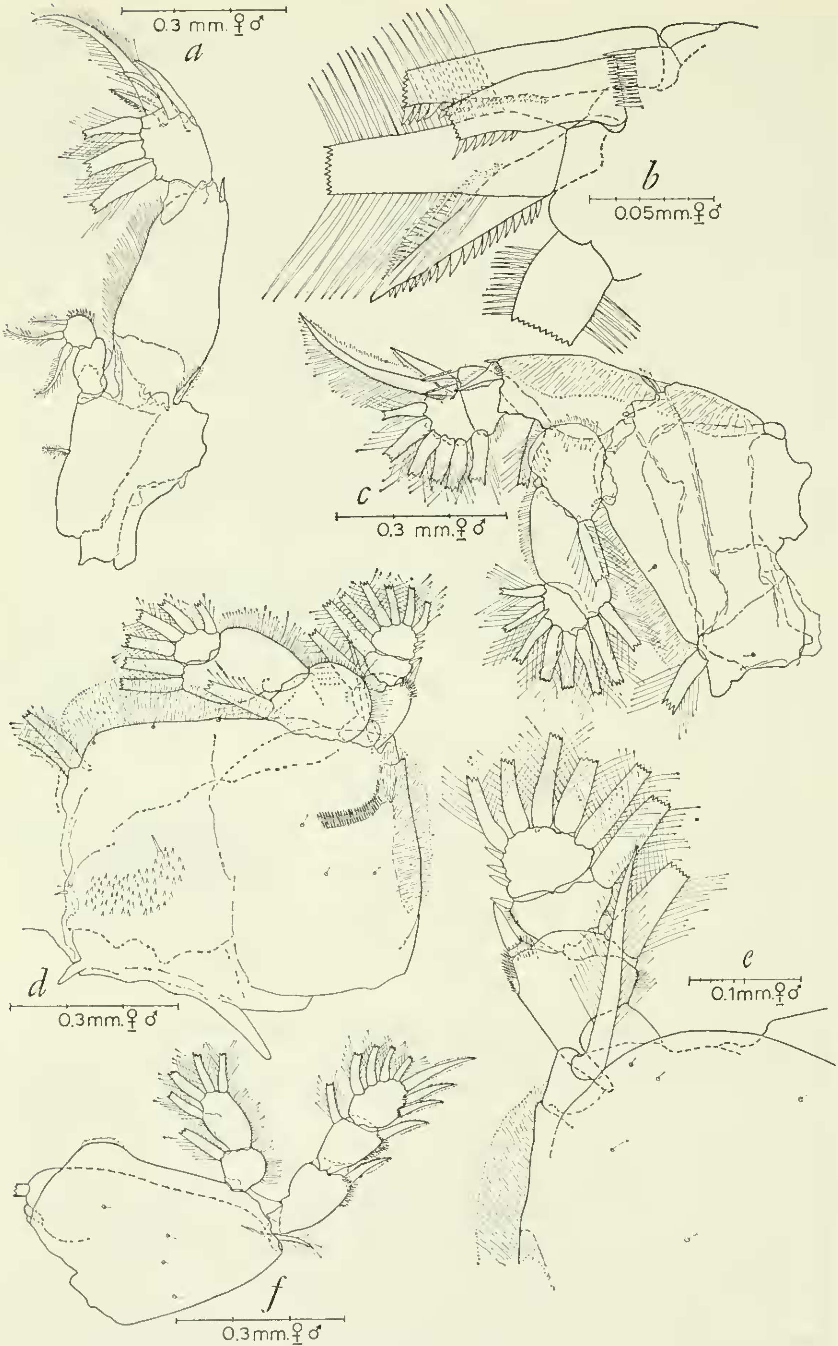


FIGURE 15.—*Euryphorus nordmanni* Milne-Edwards, 1840, right thoracic legs, anterior view: *a*, first; *b*, distal end of second segment of exopodite of first; *c*, second; *d*, third; *e*, exopodite of third (posterior view); *f*, fourth.

the terminal elements more broadly spaced on the exopodite and having 3 short, spinelike projections in addition to the 3 setae figured for both species). The variation present in the angle of the furcal tines, the rather confusing picture given by the terminal elements on the second segment of the exopodite of the first thoracic leg (fig. 15*b*), the similarity of the general body shape and particularly the first abdominal segment (which is considered, by this author, to be of taxonomic significance in this genus and in the genus *Elytrophora*), in addition to the similarity of other body parts described and figured in the original descriptions suggest that the two species are conspecific.

The reasons given by Steenstrup and Lütken (1861) for separating *Euryphorus nympha* from *E. nordmanni* Milne-Edwards are:

1. *E. nordmanni* has a better developed pair of antennules than *E. nympha*.

2. The specimens in the Paris museum (*E. nordmanni*) were from the "Asiatic" ocean while *E. nympha* was described from material collected in the subtropical Atlantic.

Kner (1859) described *E. nordmanni* from fish captured off Zanzibar. Steenstrup and Lütken, however, did not feel that Kner had sufficient material or sufficient experience (based at least partially on his misinterpretation of the first thoracic legs) to identify his specimens properly and felt that his material was *E. nympha*.

Specimens identified as either *E. nympha* or *E. coryphaenae* have been reported from most of the tropical and subtropical regions of the world (Japan, Indian Ocean, Atlantic, West Indies, Gulf of Mexico). The distribution of *E. nympha* (recognizing *E. coryphaenae* as a synonym of this species) appears to parallel that of the principal host, *Coryphaena hippurus* Linnaeus. The host that Milne-Edward's and Kner's specimens came from is unknown and *E. nordmanni* has been reported only once, from *Coryphaenae hippurus*, since Kner's publication (Kirtisinghe, 1937). Even this report was later believed erroneous, Kirtisinghe (1964 and personal communication) feeling that his specimens should have been identified as *E. nympha*.

The validity of *E. nympha* appears to be dependent upon the absence of the host name in the original description of *E. nordmanni*, the different locality from which *E. nordmanni* was collected, and the belief that *E. nordmanni* has a better developed pair of antennules. There even appears to have been some question, by Steenstrup and Lütken (1861), as to whether their species, *E. nympha*, was distinct. The following is a translation of the second footnote on page 366 of their 1861 publication:

There is, unfortunately, an almost complete lack of precedent as to whether or not we can refuse to equate an animal type to one already described in the literature just because one is from the Atlantic and one from the Indian Ocean.

Are the larger pelagic fish forms actually the same for these two oceans, or does each have their own characteristic species? So little is at present known about this that one assumption appears to be valid as the other. We are inclined to prefer the latter, and do therefore not wish to accept that the same species of parasitic crustaceans occur in both oceans as long as a possible comparison is lacking.

The wide distribution and the similar and unique morphology of the *E. nordmanni-E. nympha-E. coryphaenae* complex indicates, to this author, that these 3 species are synonymous.

Elytrophora Gerstäecker, 1853

Diagnosis.—Cephalothorax consisting of cephalon and first 4 thoracic segments, frontal region distinct; lateral margins with slight indentation medially. Free fourth pedigerous segment with alae extending posteriorly over anterior region of genital segment; female alae with sharp indentation medially, male alae with or without slight indentation. Female genital segment variable in size and shape, longer in egg-producing females than in immature females, with pair of posteriorly projecting, lobe-shaped plates, plates straight or angled inward slightly. Male genital segment without plates. Abdomen 2-segmented, first segment of female with small, posteriorly projecting lateral lobes, lobes of variable size and shape; first segment of male without lobes. Second segment of abdomen with small, bilobed anal projection. Antennule 2-segmented; antenna 3-segmented, with clawlike terminal process (male with small secondary spine at base of terminal process). Mandible rodlike, with 12 denticulations on inwardly curved distal region. Maxillule nodular, bearing setules; maxilla 2-segmented; postoral process spinelike, distal region more slender in mature specimens than in immature. Maxilliped 2-segmented, with clawlike terminal process. Thoracic legs I–IV biramous although endopodite of first and fourth legs reduced; ramal count 2–2, 3–3, 3–3, 3–2. Fifth legs present, setiform.

Remarks.—The similarity of *Euryphorus* and *Elytrophora* is remarkable. This similarity is principally in the general shape of the cephalothorax, the female alae, genital plates, abdominal processes (although they are much larger in *Euryphorus*), and number of segments in the rami of the first 4 pairs of thoracic legs (identical in members of both genera).

Elytrophora brachyptera Gerstäecker

Figures 16–21

Elytrophora brachyptera Gerstäecker, 1853, p. 60, pl. 3, fig. 12.—Nordmann, 1864, p. 468.—Heller, 1866, p. 753.—Van Beneden, 1870a, p. 57.—Richiardi, 1880, p. 3.—Stossich, 1880, p. 257.—Valle, 1880, p. 60.—Carus, 1885, p. 360.—

Bassett-Smith, 1896a, p. 158; 1896b, p. 12, pl. 4, fig. 3.—Brian, 1899a, p. 4.—Bassett-Smith, 1899, p. 462.—Brian, 1906, p. 51, pl. 1, figs. 2–3; 1908, p. 3; 1912, p. 10.—Scott and Scott, 1913, p. 83, pl. 19, fig. 10; pl. 23, figs. 1–2; pl. 31, figs. 1–6.—Yamaguti, 1936b, p. 3.—Bonnet, 1948, p. 7.—Delamare-Deboutteville and Nunes-Ruivo, 1953, p. 202, fig. 1.—Shiino, 1954b, p. 279, figs. 3–4.—Heegaard, 1955, p. 46, figs. 9–11.—Shiino, 1957a, p. 364.—Yamaguti, 1963, p. 102, pl. 123, fig. 1.

Dinematura Thynni Krøyer, 1863, p. 157.—Wilson, 1907a, p. 376 (as *thynni*). [Nomen nudum, label name attributed to Kollar.]

Arnaeus thynni Krøyer, 1863, p. 157, pl. 8, fig. 5a–g.

MATERIAL.—15+ host records:

locality	*hosts*	*reference*
Mediterranean	Unknown	Gerstäecker, 1853
	Thynnus vulgaris	Heller, 1866
	Thynnus thynnus	Brian, 1899a
	"Germon"	Brian, 1908
	"Thon rouge"	Delamare-Deboutteville and Nunes-Ruivo, 1953
Northeastern Atlantic	*Thynnus vulgaris*	Van Beneden, 1870a
	Thynnus thynnus	Bassett-Smith, 1896a
	Orcynus thynnus	Scott and Scott, 1913
Subtropical Atlantic	Plankton?	Heegaard, 1955
Pacific	*Thynnus thynnus*	
	T. alalunga	Yamaguti, 1936a
Western Pacific	*Thynnus orientalis*	
	Parathynnus sibi	Shiino, 1954a
	Neothunnus albacora	
	Parathunnus obesus	Shiino, 1957a
Hawaii	*Thynnus* species	Bonnet, 1948

MATERIAL.—Two adult females and 4 adult males (USNM 112876) from the gill cavity of *Parathunnus sibi* Schlegel from the Honolulu Fish Market (USFWS collections). Two adult females and 1 adult male (USNM 112877) from the gill cavity of *Neothunnus macropterus* (Schlegel) captured by longline near Christmas Island (Line Islands) (JRM cruise 27, longline station 2). Four adult females (USNM 112878) from inside operculum of an unknown host (probably *N. macropterus* (Schlegel)) captured by longline north of Christmas Island (Line Islands) (LL cruise 6). Additional specimens, retained by the author, include 2 adult females and 2 adult males from inside operculum of unknown host captured by longline north of Christmas Island (Line Islands) (USFWS); 1 adult female and 1 adult male from the external surface of *N. macropterus* (Schlegel) captured by longline at 0°29′N, 157°49′W (USFWS); 3 adult males from inside operculum of unknown host captured by longline north of Christmas Island (Line Islands) (USFWS); 2 adult females from inside operculum of unknown host captured by longline north of Christmas Island (Line Islands) (USFWS).

Measurements.—(In mm) 10 females and 10 males:

	female		male	
	mean	*range*	*mean*	*range*
Total length, excluding caudal setae	8. 37	6. 23– 9. 68	6. 33	5. 10–7. 80
Length of cephalothorax, including frontal region	4. 43	2. 85– 4. 88	3. 45	3. 23–4. 05
Width of cephalothorax	4. 51	3. 48– 4. 95	3. 10	2. 48–3. 60
Length of genital segment, excluding genital flap	1. 93	1. 13– 2. 37	1. 45	1. 18–1. 70
Width of genital segment	1. 70	0. 72– 1. 95	1. 27	0. 58–1. 43
Length of abdomen	1. 27	0. 99– 1. 52	1. 04	0. 70–1. 44
Length of alae (N=9 in female)	1. 21	1. 00– 1. 33	0. 73	0. 56–0. 85
Length of genital flap	0. 87	0. 70– 1. 15		
Length of caudal rami	0. 57	0. 49– 0. 63	0. 53	0. 44–0. 63
Length of egg strings (4 strings)	9. 13	7. 50–10. 50		

Remarks.—Two sets of descriptions are given below, the first for the mature adult, the second for the immature adult. The author feels that the changes that occur in the adult life history stage, as indicated in the measurements, may have caused some confusion in the taxonomy of the genus. The bases for this belief are given in the discussion section, following the description of the species.

Description.—(Mature adult): Female cephalothorax (fig. 16*a*) ovoid, consisting of cephalon and first 4 thoracic segments. Frontal region distinct, length approximately one-twelfth that of entire cephalothorax, with median cleft and narrow membrane along anterior margin. Lateral cephalothoracic margins with indentation medially, distinct in some specimens, indistinct in others; margin with fine membrane. Posterior lateral cephalothoracic region broadly rounded, extending past median posterior region, with socket-like depression (not figured); posterior sinus (fig. 16*c*) distinct, U-shaped, with fine membrane along outer margin. Median-posterior region with pair of small lobes laterally. Major dorsal cephalothoracic grooves forming irregular H, anterior legs extending past indistinct ocular region (ocular region not figured). Dorsal cephalothoracic surface without plumosities but with minute, spikelike irregularities laterally and small denticulations posteriorly.

Free fourth pedigerous segment, excluding alae, approximately one-fifth width of cephalothorax, widest medially, at origin of fourth thoracic legs. Alae sharply indented on median lateral margin, extending posteriorly over anterior end of genital segment. Division between fourth pedigerous and genital segments distinct, demarcated ventrally by ridgelike transverse projection.

Female genital segment (fig. 16*d*) of variable shape, narrow anteriorly in some specimens, broad in others, posterior dorsal surface with pair of lateral lappets, lappets distinct from segment. Dorsal surface of segment lightly rugose, extending laterally slightly past ventral region. Fifth legs (fig. 16*f*) arising from posterior lateral surface of dorsal overlap, consisting of 2 nodules, anteriormost with single setule, posterior with 3 setules.

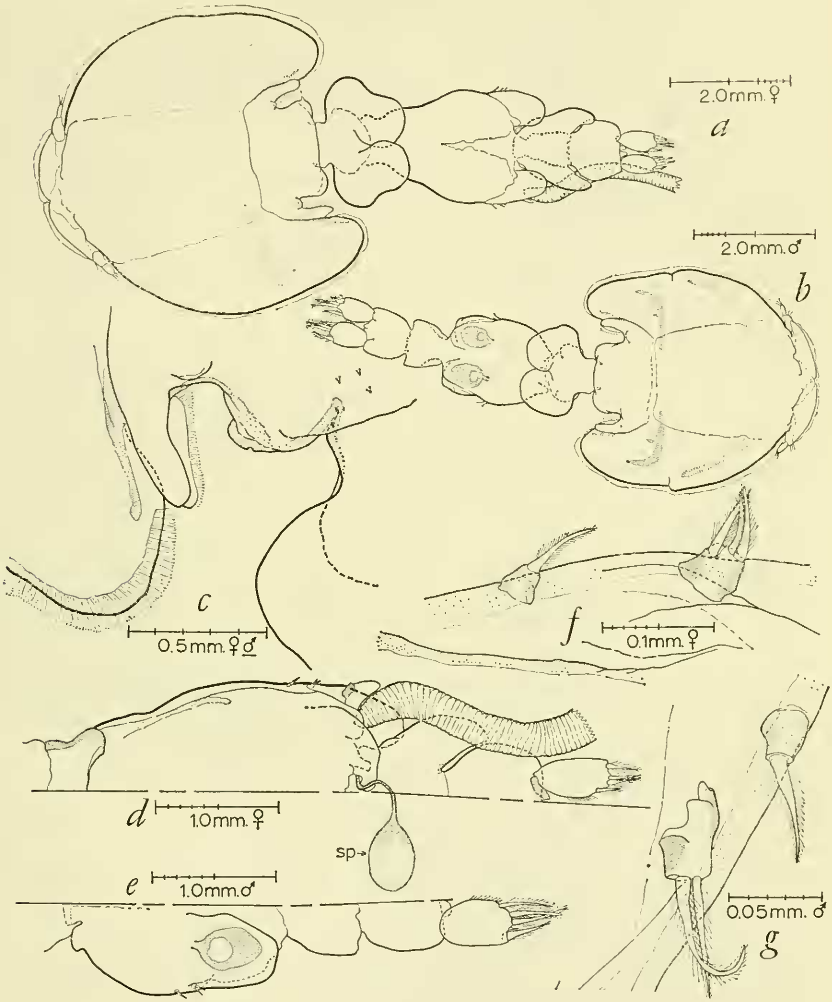


FIGURE 16.—*Elytrophora brachyptera* Gerstäecker, 1853, matuıe adult, dorsal view: *a*, female; *b*, male; *c*, posterior cephalothoracic sinus. Ventral view: *d*, female genital segment showing spermatophore (sp), abdomen, and caudal ramus; *e*, male genital segment, abdomen and caudal ramus; *f*, female left fifth leg; *g*, male left fifth leg.

Abdomen 2-segmented, distinct from genital segment ventrally, indistinctly separable dorsally. First segment, excluding lateral projections, slightly shorter than second, with pair of distinct, flap-like projections extending laterally and posteriorly, to middle of second segment. Second segment convex laterally, flat posteriorly except for slight, bilobed anal projection. Caudal rami broad, with 4 plumose setae and 2 lightly plumose setules distally, with row of fine denticulations around base of outermost seta.

Male cephalothorax (fig. 16*b*) similar to that of female although lateral indentations more distinct. Alae on free fourth pedigerous segment tapered laterally, without sharp constriction present in female. Genital segment (fig. 16*e*) with flatly convex lateral margins anteriorly, almost straight lateral margins posteriorly. Fifth legs (fig. 16*g*) similar to those of female except posteriormost nodule with 2 lightly plumose setules instead of 3. Abdomen 2-segmented, first segment narrow anteriorly, angled to widest point medially, lateral margins straight posteriorly. Second segment and caudal rami similar to that in female.

Female and male antennule (fig. 17*a*) 2-segmented, attached to anterior-lateral ventral surface of cephalothorax and adjacent portion of frontal region. First segment slightly less than twice the length of second, tapered distally, bearing 23 naked or lightly plumose setae and setules on distal half of anterior ventral surface and distal ventral surface. Second segment club shaped, with 14 naked setules distally. Female antenna (fig. 17*b*) 3-segmented, situated posterior and medial to antennule base. First segment short, irregular, with well-developed, posteriorly projecting spine from lateral posterior surface. Second segment broader proximally than distally, with minute setule on distal inner surface (not figured); third segment fused with clawlike terminal process, bearing flabby, setalike accessory process proximally, more elongate, setalike accessory process from median third, at break in sclerotization suggesting point of fusion of segment and terminal process. Male antenna (fig. 17*c*) similar to that of female although projection on first segment shorter, with secondary claw on terminal process of third segment.

Female and male mandible (fig. 17*b*) rodlike, jointed in proximal medial region, proximal portion tapered to joint, distal part flattened distally, with indistinct break at beginning of flattened part; flattened region curved inward, with 12 denticulations along inner margin Female and male postantennal process (fig. 17*b*) consisting of 2 nodules, each bearing several hairlike projections. Female and male postoral process (fig. 17*b*) broadly based, distally slender, spinelike, curving laterally distally. Maxillule (fig. 17*b*) situated lateral to mouth cone base, immediately anterior to postoral process, consisting of node bearing naked seta and 2 naked setules. Maxilla (fig. 17*d*) 2-segmented, situated lateral and slightly posterior to postoral process. First segment slightly less than four-fifths the length of second, excluding terminal processes. Second segment elongate, broadest medially,

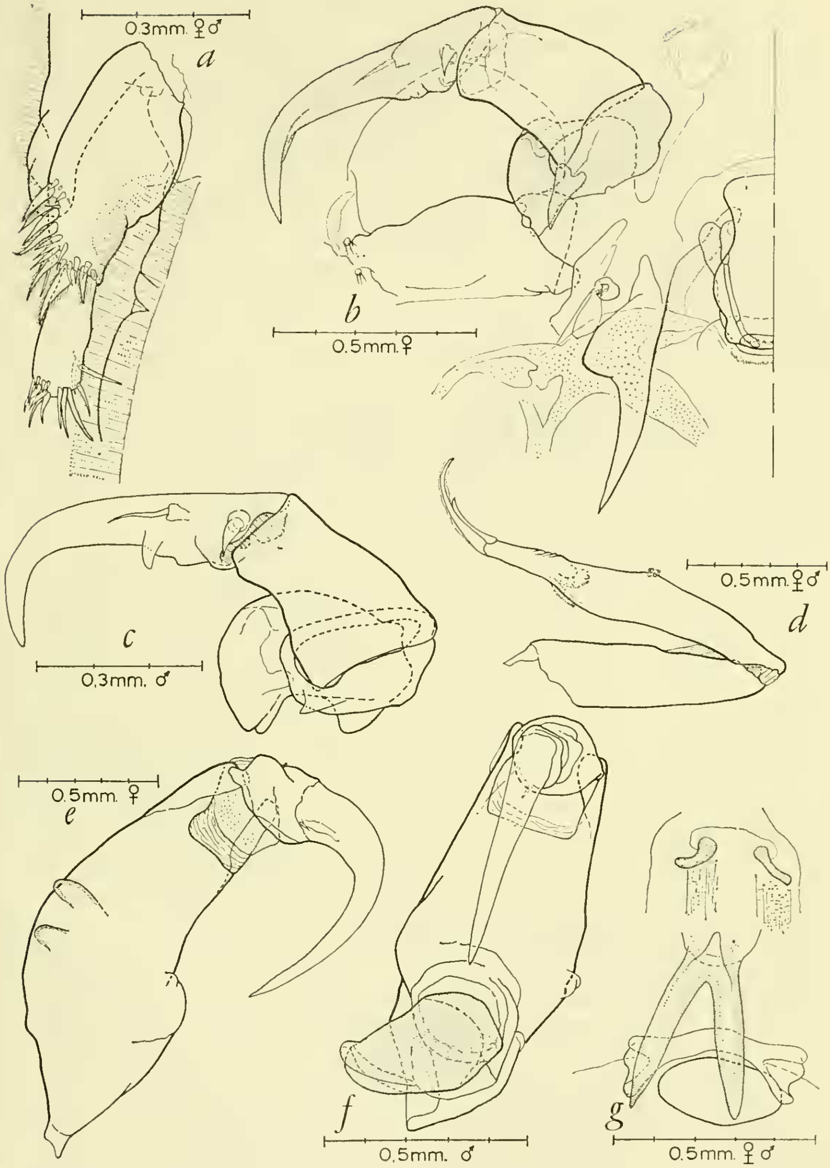


FIGURE 17.—*Elytrophora brachyptera* Gerstäecker, 1853, mature adult, ventral view: *a*, right antennule; *b*, female oral region, right side showing antenna, postantennal process, mouth cone, mandible, maxillule, and postoral process; *c*, male right antenna; *d*, left maxilla; *e*, female maxilliped; *f*, male maxilliped; *g*, sternal furca.

with small, fan-shaped projection from outer margin at widest point and 2 larger, frilled membranes more distally, 1 on inner surface, second on outer. Second segment also with small roughened area on distal outer surface, similar to that of adhesion surface; distal end bearing 2 setalike terminal processes, innermost slightly less than twice the length of outer, with fine membrane along outer and inner margin, outermost with finely frilled membrane along outer margin.

Female maxilliped (fig. 17*e*) 2-segmented, situated posterior and slightly medial to maxilla base. First segment strongly developed, narrow proximally and distally, broad medially, with pair of small, shelflike projections on medial posterior surface. Second segment short, distinct from clawlike terminal process, with setule-like accessory process on inner surface, at junction of segment and terminal process. Male maxilliped (fig. 17*f*) differing from that of female by presence of large, lobate projection from proximal inner surface of first segment, projection containing heavily sclerotized, clawlike process; ridges on first segment not as distinct as in female.

Female and male sternal furca (fig. 17*g*) V-shaped, tines slender, extending posteriorly over interpodal plate of first thoracic legs.

For nature of legs and armature, see figures 18*a–f* and table 8. Small, platelike projection present immediately behind interpodal plate of first thoracic legs, with minute nodules in immature adults, similar to those of *Euryphorus nordmanni* Milne-Edwards.

Description.—Immature adult. Female cephalothorax (fig. 19*a*) ovoid, consisting of cephalon and first 4 thoracic segments. Frontal region approximately one-twelfth the total length of cephalothorax, with median cleft and narrow membrane on anterior margin. Lateral cephalothoracic margins convex, with membrane; with distinct indentation medially, indentation formed by folding of dorsal cuticle, extending inward to median cephalothoracic region. Posterior lateral cephalothoracic region broadly rounded, terminating at junction with median cephalothoracic region, forming outer surface of posterior sinus (fig. 19*c*). Sinus irregularly U-shaped, outer margin with fine, irregular membrane. Posterior median cephalothoracic region not extending to end of posterior lateral cephalothoracic region, margin lobed laterally, flat medially, distinct from anterior end of free fourth pedigerous segment. Major dorsal cephalothoracic grooves forming irregular H, anterior legs of H extending to just posterior to ocular region, turning inward sharply. Ocular elements distinct. Dorsal cephalothoracic surface with numerous, elongate plumosities arranged in 2 groups, one extending anteriorly, from just posterior to crossbar of dorsal cephalothoracic grooves, to anterior region of longitudinal grooves; second group, containing fewer plumosities, located on posterior lateral cephalothoracic region.

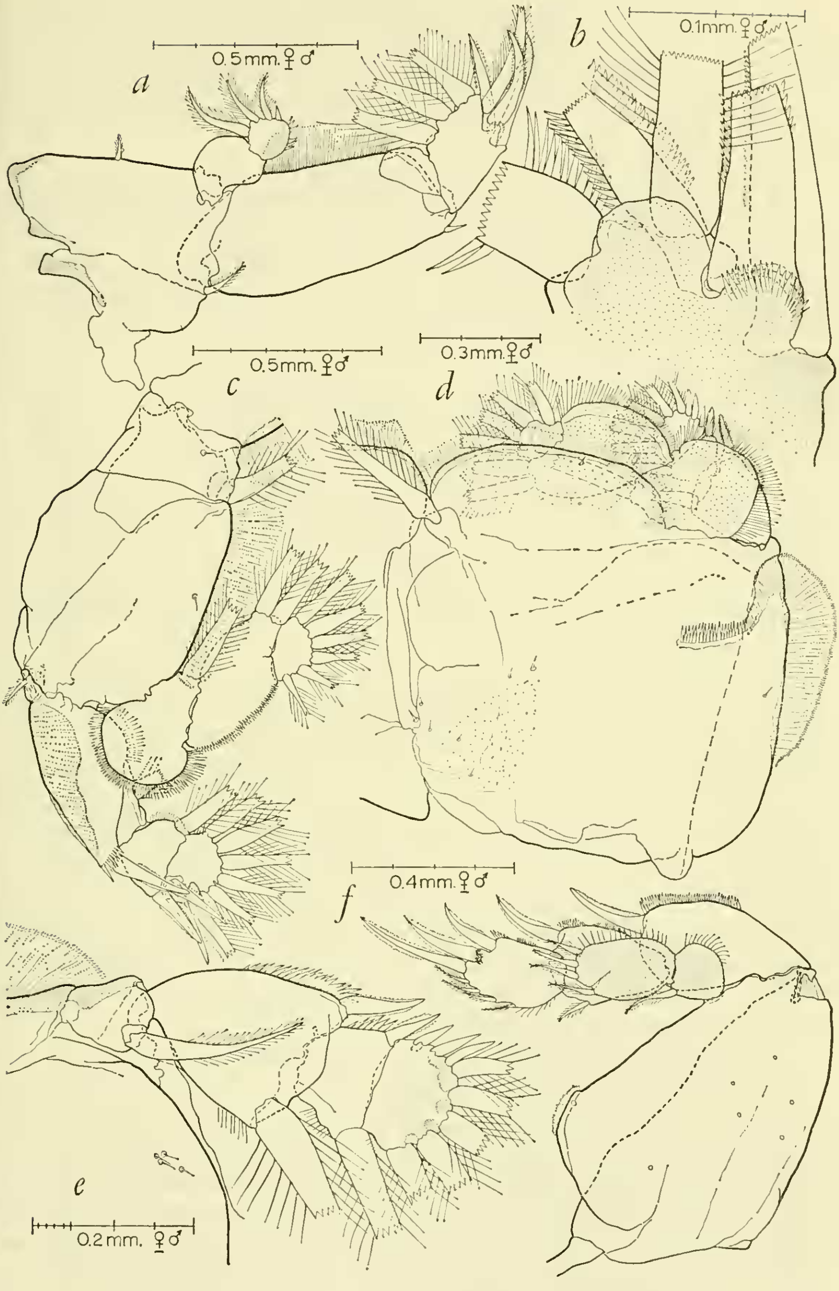


FIGURE 18.—*Elytrophora brachyptera* Gerstäecker, 1853, mature adult, right thoracic legs, anterior view: *a*, first; *b*, second segment of exopodite of first; *c*, second; *d*, third; *e*, exopodite of third (posterior view); *f*, fourth.

Female free fourth pedigerous segment, excluding alae, slightly more than one-fifth the width of cephalothorax, widest medially, at attachment of fourth thoracic legs. Alae widest anteriorly, constricted medially, broadly rounded posteriorly, covering anterior third of genital segment.

Female genital segment (fig. 19*d*) broadly rounded anteriorly, lateral margins flatly convex, lateral-posterior dorsal surface extending posteriorly as pair of lobate projections, projections not distinct from genital segment. Dorsal surface of genital segment platelike, extending laterally past somewhat irregular posterior ventral surface. Fifth legs (fig. 19*f*) arising from ventral lateral surface of platelike projection of dorsal surface of genital segment, consisting of pair of nodules, anteriormost with single setule, posterior with 3 setules. Ovoid, adhesion-like surface present just posterior to fifth legs.

Female abdomen 2-segmented, distinct from genital segment. First segment slightly shorter than second, broader anteriorly than posteriorly, with slight posterior lateral projections; second segment with convex lateral margins and slight, bilobed, anal projection. Caudal rami broad, with 4 plumose setae and 2 naked or very lightly plumose setules from distal surface, with row of fine denticulations around base of outermost seta.

Male cephalothorax (fig. 19*b*) similar to that of female although somewhat narrower, without dorsal plumosities or distinct projections indicating previous presence. Free fourth pedigerous segment more drawn out medially than in female, alae not as large, without medial constriction present in female. Genital segment (fig. 19*e*) basically ovoid, without platelike dorsal part and posterior extensions of female; fifth leg (fig. 19*g*) similar to that of female, genital segment without adhesion-like surface present in female. Abdomen 2-segmented, first segment slightly shorter than second, overlapping second dorsally; second segment tapered anteriorly, with flatly convex lateral margins and bilobed anal projection. Caudal rami as in female although more plumose along inner margin.

Female and male antennule (fig. 20*a*) 2-segmented, most of anterior surface of first segment overlapped by ventrally curved lateral surface of frontal region. First segment slightly more than twice the length of second, broad proximally, tapered irregularly to narrow distal end, with small, knoblike projection from posterior distal surface, with 15 naked or lightly plumose setules from anterior ventral and distal ventral surfaces in female, male with 19 naked or lightly plumose setules. Second segment subrectangular, with 1 naked setule from median dorsal surface, second from distal posterior surface, and 8 or 9 naked setules from distal surface. Female antenna (fig. 20*b*) 3-segmented, situated medial and posterior to antennule base. First

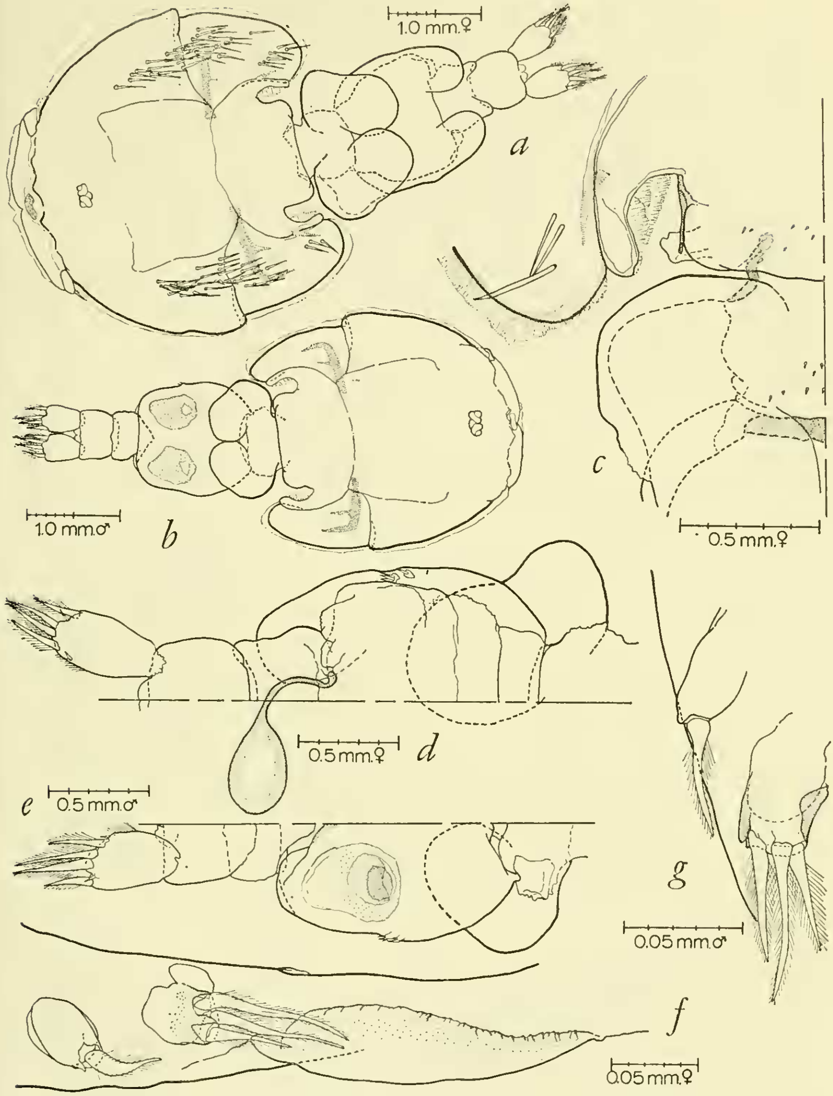


FIGURE 19.—*Elytrophora brachyptera* Gerstäecker, 1853, immature adult, dorsal view: *a*, female; *b*, male; *c*, lateral posterior cephalothoracic region and free fourth pedigerous segment. Ventral view: *d*, female free fourth pedigerous segment, genital segment (showing attached spermatophore), abdomen, and caudal ramus; *e*, male free fourth pedigerous segment, genital segment, abdomen, and caudal ramus; *f*, right fifth leg and genital fold of female; *g*, male right fifth leg.

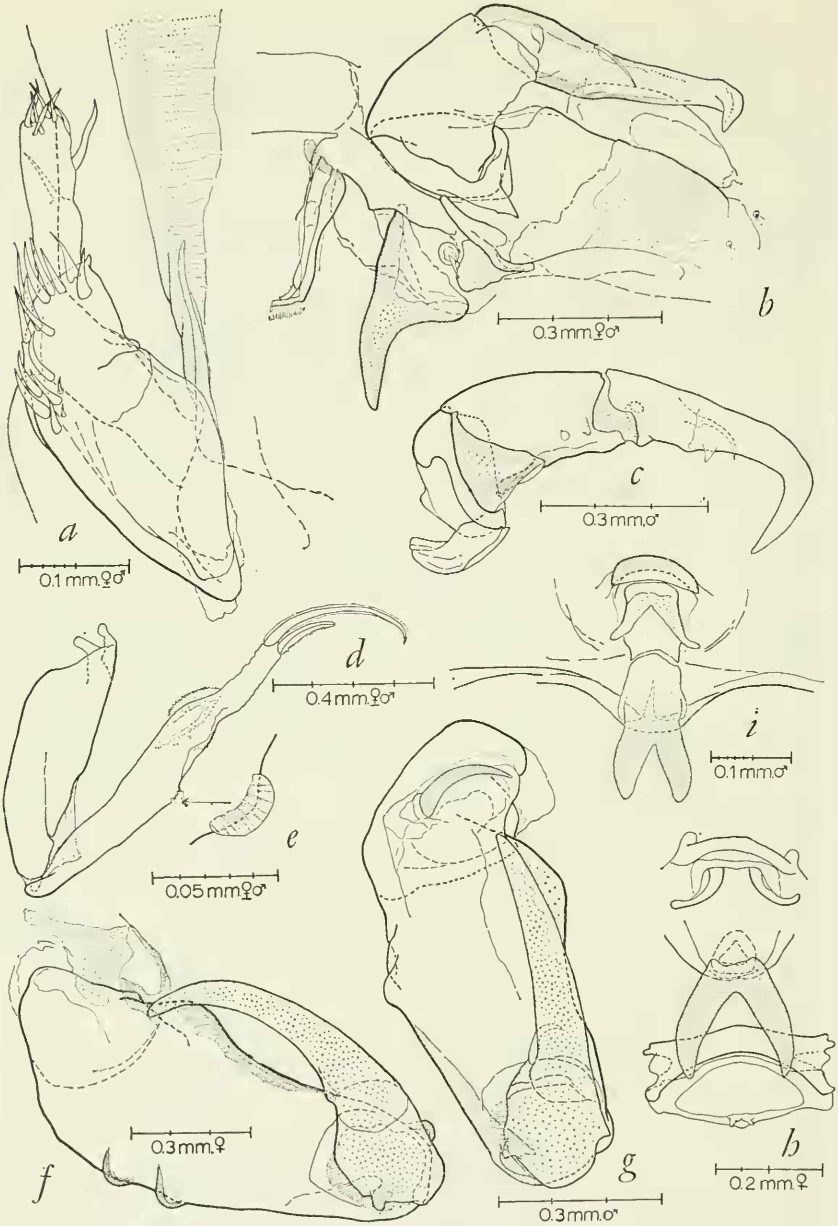


FIGURE 20.—*Elytrophora brachyptera* Gerstäecker, 1853, immature adult, ventral view: *a*, left antennule; *b*, oral region, left side showing antenna (female), postantennal process, mouth cone, mandible, maxillule, and postoral process; *c*, male right antenna (lateral view); *d*, right maxilla; *e*, membrane on right maxilla; *f*, female left maxilliped; *g*, male left maxilliped; *h*, female sternal furca, interpodal plate of first thoracic leg (ip) and projection between interpodal plates of first and second thoracic legs; *i*, male sternal furca.

segment short, irregular, with triangular projection from lateral posterior surface; second segment approximately 4 times the length of first, broader proximally than distally. Third segment fused with clawlike terminal process, with flabby, setalike accessory process from proximal surface and elongate, setalike accessory process from medial third, at break in sclerotization suggesting distal end of segment and proximal end of terminal process. First segment of male antenna (fig. 20*c*) similar to that of female although triangular projection smaller; second segment with pair of minute, lappet-like projections medially and small adhesion surface (not figured) on slight swelling of distal posterior surface. Third segment separable from clawlike terminal process, bearing same accessory processes as in female; terminal process strongly curved distally, with small, pointed secondary projection proximally.

Female and male mandible (fig. 20*b*) 2-parted, first part short, tapered distally, with indistinct break at beginning of taper. Second part elongate, flattened distally, with indistinct break just proximal to flattened part, distal inner surface with 12 denticulations. Female and male postantennal process (fig. 20*b*) consisting of pair of nodules, each with several hairlike processes, just lateral to padlike swelling situated lateral to antenna base. Female and male postoral process (fig. 20*b*) spinelike, with broad base and laterally curved tip, not as elongate as in mature adult specimens. Female and male maxillule (fig. 20*b*) nodular, bearing 2 setules and 1 seta. Female and male maxilla (fig. 20*d*) 2-segmented, situated lateral to postoral process. First segment slightly less than four-fifths the length of second, excluding terminal process; second elongate, with small, fan-shaped projection (fig. 20*e*) from outer surface medially, 2 additional membranes present distally; terminal processes setalike, innermost more than twice the length of outer, with membranous band and fine plumosities along margin.

Female maxilliped (fig. 20*f*) 2-segmented, situated posterior and slightly medial to maxilla base. First segment strongly developed, with pair of small, shelflike projections from posterior medial surface; second segment small, distinct from long, clawlike terminal process, bearing setalike accessory process from inner distal surface. Male maxilliped (fig. 20*g*) similar to that of female although shelflike projections of first segment smaller and proximal end of segment more complex, with heavily sclerotized, clawlike projection from proximal inner surface.

Female sternal furca (fig. 20*h*) V-shaped, overlapping interpodal plate of first thoracic legs. Male sternal furca (fig. 20*i*) similar to that of female although tines not as regular and not appearing as heavily sclerotized.

Thoracic legs I–IV differing from those of adult specimens in nature of segment divisions and minor armature elements (e.g., division between first and second segments of protopodite of second thoracic leg indistinct in female; plumosities on ramal segments not as extensive). For nature of legs and armature see figures 21*a-f* and table 8. Small, platelike projection present just posterior to interpodal plate of first thoracic legs, projection bearing pair of minute nodules from median distal surface.

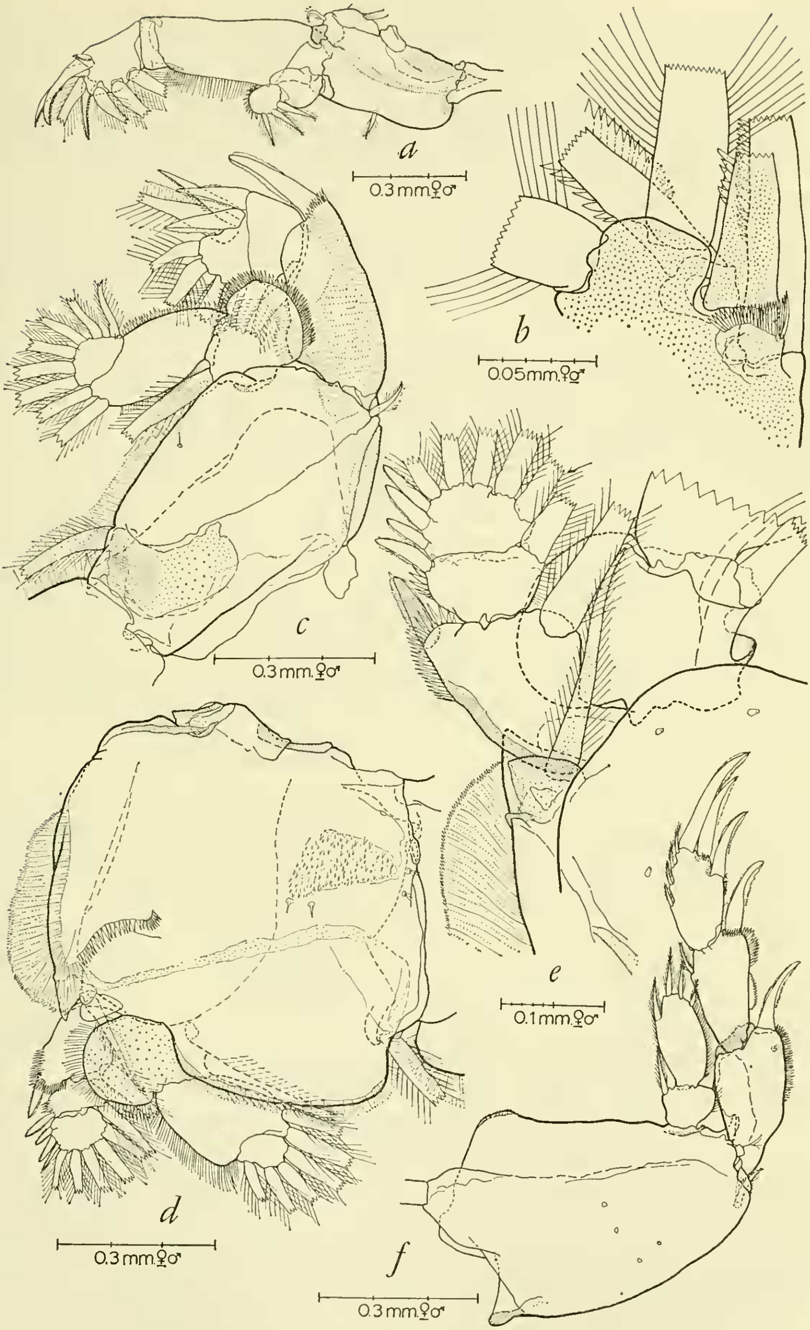
TABLE 8.—*Armature of thoracic legs I–IV of the female and male of* Elytrophora brachyptera *Gerstäecker, 1853*

Leg	Surface	Interpodal Plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer		s,p		rh§	dm,3dmH			C	
	Inner		p		c	4P			3p	
II	Outer	m		m,p	m,d,dmH	dmH	2dmH,Q	C	C	2P
	Inner		s,P	m,s	c,P	c,P	c§,5P	P	c,2P	4P
III*	Outer	m	fm,dm,P		dm,dmH	dm,fmH	3fmH,2P	c	c	2P
	Inner		d†,2d,5s, P,m,4s		c,P	c,P	c§,3P	P	c,2P	2P
IV*	Outer		s§,p		dm,fmH	fm,dm,fmH	fm,dm, fmH,fm, 2fmH	c	c,3p‡	
	Inner		fm,s§			c§,4p‡		p‡	p‡	

*Numerous, hairlike processes on protopodite not tabulated.
†Denticulations very small.
‡Larger in male than in female.
§Not present in immature adults.

DISCUSSION.—The measurements, descriptions, and figures of the 2 adult stages of *Elytrophora brachyptera* indicate that a morphological change takes place in the transition from the immature to the mature condition. This, however, is not the first time that this has been indicated. Heegaard (1955) points out some of the differences between his immature "Atlantide" material and figures of the adult *E. brachyptera*. Among these he indicates (p. 46) that the sternal furca in the adult "is delicate with two long pointed branches with a V-shaped incision between them. In the young 'Atlantide' specimens the furca is not fully grown and therefore more plump in the peduncle, shorter in the branches which are more blunt at their points and together shaping a U instead of the V in the adult." This age variation, which is present to a lesser degree in the immature adult specimens used for this description,

FIGURE 21.—*Elytrophora brachyptera* Gerstäecker, 1853, immature adult, right thoracic legs, anterior view: *a*, first; *b*, second segment of exopodite of first; *c*, second; *d*, third; *e*, exopodite of third (posterior view); *f*, fourth.


a
0.3 mm ♀♂
b
0.05 mm ♀♂
c
0.3 mm ♀♂
d
0.3 mm ♀♂
e
0.1 mm ♀♂
f
0.3 mm ♀♂

can also be found in many other characteristics. The presence of plumosities on the dorsal surface of the cephalothorax in immature adult (with spermatophore) female specimens is suggested only by small, spikelike irregularities in ovigerous female specimens. The dimensions of the female genital segment become larger as egg production begins; the angle changes at the point where the genital flap projects, and the flap becomes distinct from the segment in the mature adult female. The projections on the first abdominal segment of the female greatly enlarge in the transition from the immature to mature adult condition. The claw-containing process on the proximal inner surface of the male maxilliped is poorly sclerotized: the claw projects in the immature state while it is heavily sclerotized and is covered by the cuticle in the mature adult. The described differences in the armature of the thoracic legs are more difficult to reconcile although specimens collected from the same species of host in the same geographic area (Line Island specimens) exhibit this variation. Most of the change, however, occurs in the genital segment, the abdomen, and the amount of sclerotization. These variations are evident not only in the material used for this description but also in specimens identified as *E. brachyptera* by C. B. Wilson (USNM 78931). It is suggested, therefore, that some of the characteristics previously used in the taxonomy of the species in the genus should be reexamined on the basis of the maturity of the specimens.

Gloiopotes Steenstrup and Lütken, 1861

Diagnosis.—Cephalothorax ovoid, consisting of cephalon and first 4 thoracic segments, with spines or hairlike processes, or both, on dorsal surface. Free fourth pedigerous segment with alae. Female genital segment with pair of lobate projections posteriorly. Fifth legs large, heavily sclerotized, projecting past genital segment proper, either rodlike or lobate; sixth legs, if present, strongly reduced. Abdomen elongate, 2-segmented, caudal rami rodlike. Antennule 2-segmented; antenna 3-segmented, with clawlike terminal process, male terminal process modified. Mandible rodlike, distal surface slightly flattened, with 12–13 denticulations along inner surface. Maxillule nodular, with several setalike processes; maxilla 2-segmented. Postantennal process consisting of plate bearing 1 or more spinelike projections and 2 nodules, each with several hairlike processes; postoral process spinelike, bifurcate, or simple. Maxilliped 2-segmented, prehensile. Thoracic legs I–III biramous although endopodite of first leg reduced; fourth thoracic leg uniramous. Ramal count of first 4 thoracic legs 2–2, 3–3, 3–2, 3; second segment of exopodite of first leg tipped by 1 simple and 2 bifid spines, bifid spines with spinelike accessory process.

Gloiopotes huttoni (Thomson)

Figures 22–24

Lepeophtheirus huttoni Thomson, 1889, p. 354, pl. 28, fig. 10a–c; pl. 29, fig. 1a–m.
Gloiopotes huttoni (Thomson) Bassett-Smith, 1899, p. 458.—Hewitt, 1964a, p. 86, figs. 1–16.—Yamaguti, 1963, p. 104.
Gloiopotes costatus Wilson, 1919, p. 313, pl. 21; 1937, p. 429.—Yamaguti, 1963, p. 103.
Caligus longicaudatus Marukawa, 1925, p. 1243, fig. 2396; 1947, p. 927, fig. 2654.
Gloiopotes watsoni Kirtisinghe, 1934, p. 167, figs. 1–17.—Yamaguti, 1963, p. 104, pl. 126, fig. 1.
Gloiopotes species Yamaguti, 1936b, p. 4, pl. 2, fig. 20; pl. 3, figs. 21–35.
Gloiopotes zeugopteri Rao, 1951, p. 248, figs. 1–15.
Gloiopotes longicaudatus (Marukawa) Shiino, 1954b, p. 273, figs. 1–2; 1957a, p. 364; 1958, p. 105; 1959a, p. 348.—Heegaard, 1962, p. 174, figs. 151–153.—Ho, 1963, p. 87, figs. 6–10.—Shiino, 1963a, p. 343.—Yamaguti, 1963, p. 104, pl. 125, fig. 1.—Kirtisinghe, 1964, p. 87, figs. 102–103.

Hosts and distribution.—24 host records:

location	*hosts*	*reference*
New Zealand	*Histiophorus herschelli*	Thomson, 1889
	Makaira mitsukurii	Hewitt, 1964a
Australia	*Marlina zelandica*	
	Istiompax australis	Heegaard, 1962
Indian Ocean	*Histiophorus brevirostris*	Bassett-Smith, 1899
	H. gladius	Kirtisinghe, 1934
	Xiphias zeugopteri	Rao, 1951
	Makaira indica	Kirtisinghe, 1964
	M. mazara	
	Tetrapturus mitsukurii	
	T. marlina	Shiino, 1958, 1959a
Eastern Pacific	"Swordfish"	Wilson, 1919
	Istiophorus greyi "Marlin"	Wilson, 1937
	"Black Marlin"	
	Makaira audax	
	Makaira species	
	Xiphias gladius	Shiino, 1963a
South Pacific	"Marlin"	Wilson, 1929?
Western Pacific	*Tetrapturus mitsukurii*	Yamaguti, 1936b
	Parathynnus sibi	
	M. mazara	Shiino, 1954b
	Istiophorus orientalis	
	Xiphias gladius	Ho, 1963

Material.—Two females and 2 males (USNM 112879) collected by D. W. Strasburg (USFWS) from external surface of *Makaira ampla* (Poey) captured by rod and reel off Kona, Hawaii. Thirteen females and 1 male (USNM 112880) collected by E. C. Jones (USFWS) from external surface of *Makaira audax* (Philippi) captured off Waianae, Hawaii. Two females and 2 males (retained by author) from external surface of *Makaira audax* (Philippi) captured off Waianae, Hawaii.

Two females and 2 males (retained by author) from either *Makaira ampla*? (Poey) or *Istiompax marlina* (Jordan and Hill) examined at Honolulu Fish Market (USFWS). Two females and 1 male (retained by author) from external surface of *Makaira ampla*? (Poey) captured in Hawaiian region (USFWS).

Measurements.—(In mm) 18 females and 6 males:

	female		*male*	
	mean	*range*	*mean*	*range*
Total length, excluding caudal setae	12. 02	10. 20–12. 90	10. 25	9. 53–10. 95
Length of cephalothorax, including frontal region	5. 81	5. 03– 6. 08	4. 63	4. 35– 4. 88
Width of cephalothorax	5. 06	4. 35– 5. 63	4. 00	3. 60– 4. 28
Length of genital segment, excluding fifth legs	3. 21	2. 40– 3. 60	2. 16	1. 95– 2. 25
Width of genital segment	3. 03	2. 70– 3. 30	1. 94	1. 88– 2. 03
Length of abdomen	2. 29	1. 67– 2. 55	1. 83	1. 52– 2. 04
Length of alae (male N=5)	1. 76	1. 33– 2. 11	1. 08	0. 93– 1. 15
Length of fifth leg, measured along outer margin (male N=5)	1. 61	1. 41– 1. 78	1. 56	1. 30– 1. 63
Length of caudal rami	1. 06	0. 89– 1. 30	1. 23	1. 04– 1. 37
Length of egg strings (12 strings)	3. 34	2. 40– 4. 65		

Description.—Female cephalothorax (fig. 22*a*) ovoid, consisting of cephalon and first 4 thoracic segments. Frontal region distinct, with small, median, knoblike projection and frilled membrane on anterior margin; heavily sclerotized articulation surfaces (articulation with cephalothorax proper) present on posterior surface. Lateral cephalothoracic margins flatly convex although slightly irregular, with narrow frilled membrane and row of plumosities, membrane extending around posterior end of broadly curved posterior lateral cephalothoracic region, terminating adjacent to origin of posterior sinus. Posterior sinus (fig. 22*c*) irregularly U-shaped, open end constricted, lateral margin formed by heavily sclerotized extension of median cephalothoracic region, small, lappet-shaped dorsal projection present at anterior end of sinus in addition to small membrane along lateral margin of sinus and second, posteriorly projecting membrane, from dorsal lateral surface. Median cephalothoracic region extending to or slightly past posterior end of lateral cephalothoracic regions, margin irregular. Dorsal surface of cephalothorax with numerous hairlike projections laterally, giving fuzzy appearance; 3 rows of long, slender, bifid plumosities present on lateral regions, lateral to ocular region. Dorsal surface also with numerous spinules, primarily on median cephalothoracic region, extending around ocular region and on posterior end of median cephalothoracic region. Dorsal cephalothoracic grooves distinct, major grooves forming irregular H. Eyes distinct, in anterior third of cephalothorax.

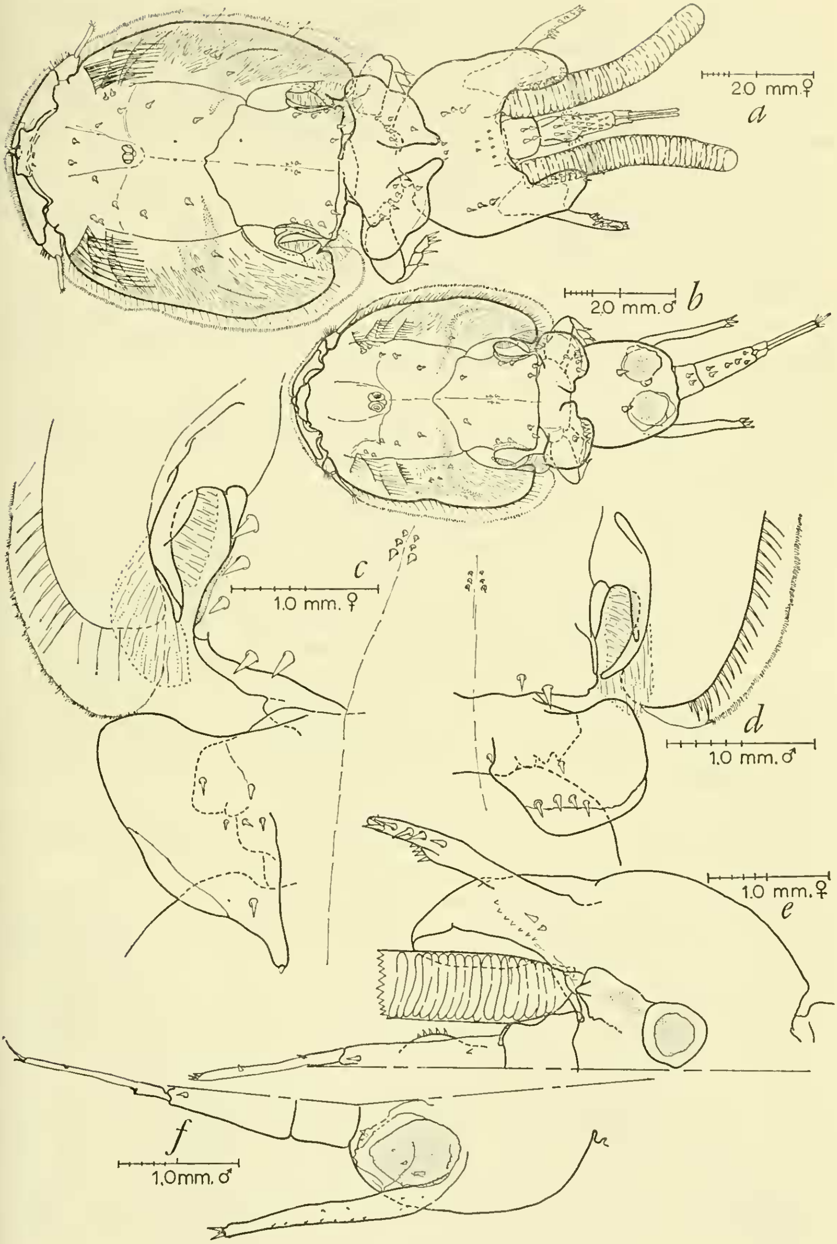


Figure 22.—*Gloiopotes huttoni* (Thomson, 1889), dorsal view: *a*, female; *b*, male; *c*, posterior portion of female cephalothorax and free fourth pedigerous segment showing ala and armature; *d*, male, same. Ventral view: *e*, female genital segment, fifth leg, abdomen, and caudal ramus; *f*, male genital segment, fifth leg abdomen, and caudal ramus.

Female free fourth pedigerous segment less than half the width of cephalothorax, tapered sharply anteriorly and posteriorly from widest point, at fourth leg attachment. Alae broad anteriorly, tapered (in figured specimen) to narrow, sharply rounded posterior end tipped with single spinule; alae rounded posteriorly in some specimens, subrectangular in others. Alae extending posteriorly, over anterior region of genital segment, bearing several spinules dorsally; medial lateral surface semimembranous.

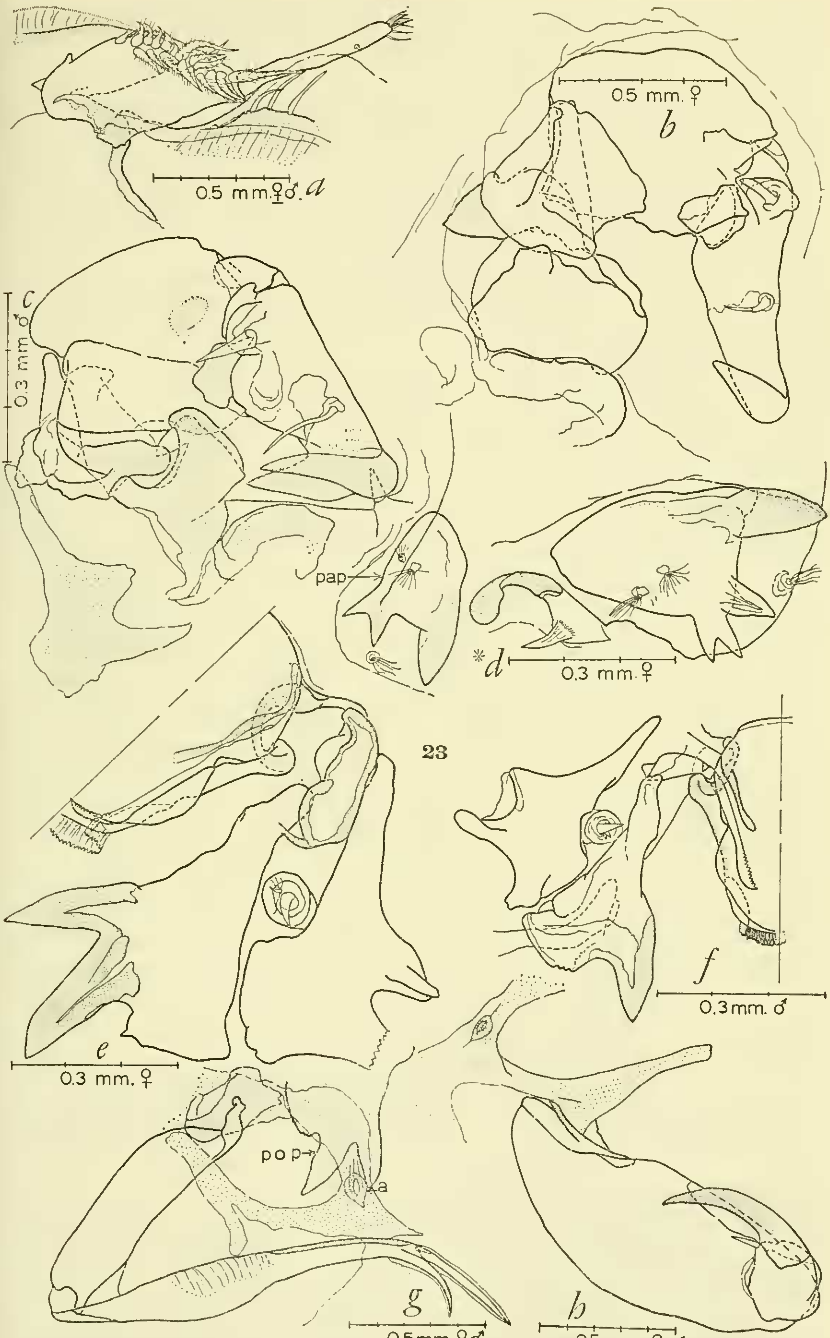
Female genital segment (fig. 22*e*) indistinctly separable from fourth pedigerous segment, broad medially, with large, lobate projection from each lateral posterior surface, lateral surface of segment roughened adjacent to lobes. Genital segment bearing strong, heavily sclerotized fifth legs projecting from ventral lateral posterior surface, at base of lobate projections; legs extending posteriorly and laterally to end of abdomen, with row of spinules on distal ventral surface and on indentation in distal medial region.

Female abdomen 2-segmented, distinctly separable from genital segment. First segment subrectangular, approximately half the length of elongate second segment; second segment with club-shaped swelling on dorsal surface. Both segments with numerous spinules. Caudal rami elongate, appearing 2-parted although "division" an indentation in lateral surface (rami not 2-segmented as indicated by Heegaard, 1962, p. 174). Distal lateral surface of rami with single spine, distal ventral surface with 1 and distal surface with at least 3 spines; several spinules present on remaining ramal surface (not figured).

Cephalothorax of male (fig. 22*b*) similar to that of female although number and arrangement of spinules on dorsal surface different. Alae of free fourth pedigerous segment (fig. 22*d*) primarily lateral expansions, without narrow, posterior extension present in female; with semimembranous trailing edge. Genital segment (fig. 22*f*) distinct from fourth pedigerous segment, ovoid in outline, without lobate posterior projections. Heavily sclerotized fifth legs projecting from posterior ventral surface, without distal medial indentation present in female, with small spinules and bearing 3 spinules from distal surface. Abdomen of both sexes similar in general outline although male without club-shaped dorsal swelling of second segment. Caudal rami similar to those of female although inner terminal process longer.

Female and male antennule (fig. 23*a*) 2-segmented, first segment

FIGURE 23.—*Gloiopotes huttoni* (Thomson, 1889), ventral view: *a*, left antennule; *b*, female left antenna; *c*, male left antenna and postantennal process (pap); *d*, female left postantennal process (*=see text); *e*, female oral region, left side showing mouth cone, mandible, maxillule, and postoral process; *f*, male, same, right side; *g*, right maxilla (pop=postoral process; a=adhesion pad, not present in male); *h*, left maxilliped.


a
0.5 mm. ♀♂
b
0.5 mm. ♀
c
0.3 mm ♂
pap
*d
0.3 mm. ♀
23
e
0.3 mm. ♀
f
0.3 mm. ♂
pop
a
g
0.5mm. ♀♂
h
0.5 mm. ♀♂

approximately 1¼ times the length of second, tapered from broad proximal to narrow distal end, bearing approximately 22 lightly plumose setae from anterior ventral and distal ventral surfaces. Second segment elongate, rod shaped, with naked setule from distal posterior surface, approximately 7 from distal surface. Female antenna (fig. 23*b*) 3-segmented, situated posterior and medial to antennule base. First segment subtriangular, small, with roughened, triangular projection from proximal posterior surface. Second segment almost twice the size of first, with small, lappet-like anterior distal projection. Third segment indistinctly separable from clawlike terminal process, with small, knoblike projection proximally, projection bearing setule-like accessory process; second setule-like accessory process present at junction of segment and terminal process. Male antenna (fig. 23*c*) 3-segmented, first 2 segments similar to those of female, third with larger accessory processes and bifurcate terminal process.

Female and male mandible (fig. 23*e*) indistinctly 3-parted, rodlike; third part flattened, distal inner surface with 12 denticulations. Small, bilobed cuticular flap present in female adjacent to mandible base. Postantennal process of figured female (fig. 23*d*) situated lateral and slightly posterior to base of antenna, consisting of platelike region of heavy sclerotization bearing large spine on lateral posterior surface, smaller spine on inner posterior surface, and bifurcate spinous projection on posterior inner surface. Platelike region also bearing 2 nodules on medial surface, each with several hairlike projections; additional nodule present just posterior to process, with several hairlike processes. Other female specimens with condition similar to that of male or with various combinations of spines (see discussion). Small, spinelike projection present adjacent to anterior inner surface of postantennal process, arising from edge of depression associated with base of antenna. Male postantennal process (fig. 23*c*) similar to that of figured female although lacking smaller of 2 single spinelike projections. Female postoral process (fig. 23*e*) bifurcate, each ramus spinelike; additional, minute, sharply pointed projection present just lateral to bifurcation. Male postoral process (fig. 23*f*) spinelike, not bifurcate as in female. Possible remnant of postoral adhesion pad present in female as minute, oblong protrusion just posterior to postoral process and medial to maxilla base. Female maxillule (fig. 23*e*) nodular, bearing single setule and cluster of hairlike processes. Male maxillule (fig. 23*f*) nodular, with 2 or 3 setules. Female and male maxilla (fig. 23*g*) 2-segmented, first segment approximately three-fourths the length of second, slender, width varying little throughout length. Second segment narrow proximally and distally, swollen medially, with indistinct membrane on medial inner surface;

distal surface bearing 2 saber-shaped processes, inner longer than outer, both with fine membranes along margins.

Female maxilliped (fig. 23*h*) 2-segmented, situated posterior and slightly medial to maxilla base. First segment strongly developed, lobate proximally, widest medially, tapered to slightly narrower distal end, without distinct irregularities. Second segment short, distinct from clawlike terminal process, with single, setule-like accessory process on inner surface, at junction of segment and terminal process. Male maxilliped similar in outline to that of female; first segment with 2 minute, lappet-like projections on inner surface, second segment with second setule-like accessory process proximally.

Sternal furca of female and male (fig. 24*a*) situated between and slightly posterior to maxilliped bases. Process basically bifurcate, arising from oval platelike area of heavy sclerotization, with spine-like projection on either side, just proximal to apex of bifurcation. Tines of bifurcation angled outward, bifurcate distally, each ramus of distal bifurcation bluntly rounded. Cuticular flap present on either side of sternal furca, with pointed projection laterally in both female and male, with rounded projection medially in female.

For nature of armature and legs, see figures 24*b–g* and table 9.

TABLE 9.—*Armature of thoracic legs I–IV of the female and male of* Gloiopotes huttoni (*Thomson, 1889*)

Leg	Surface	Inter-podal Plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer		sss,p		h			d*	2p	
	Inner		p		c	3P,p,3dH			p′	
II	Outer	m		m,p′	m,fmH†	dH	dH,H,Q,P	C	c	c,4P
	Inner		s,P	m,s	c,P	c,P	4P	P	c,2P	2P
III	Outer	m	s,m,p		H	H	3H,2P	C	c,2P	
	Inner		2ss,P, m, 2s,C§		P	c,P	c,3P	c,2P	2P	
IV	Outer‡		h,p‖		rh,3h, D,H	D,H	D,3H,D			

*Denticulations in clump in female, in row in male.
† Spine denticulated in male, not in female.
‡ Numerous spinules on protopodite and first segment of exopodite not tabulated. Spinule arrangement slightly different in two sexes.
§ Elements between rami.
‖ Elements in middle of segment, not on edge.

DISCUSSION.—*Gloiopotes huttoni* (Thomson, 1889) exhibits a wide variation in many characteristics. This variation may be a natural variation or the result of breakage and regrowth of some of the heavily sclerotized parts. The most striking example of this, in the Hawaiian specimens, is the variation in the spines associated with the postantennal process. In the figured female specimen (fig. 23*d*),

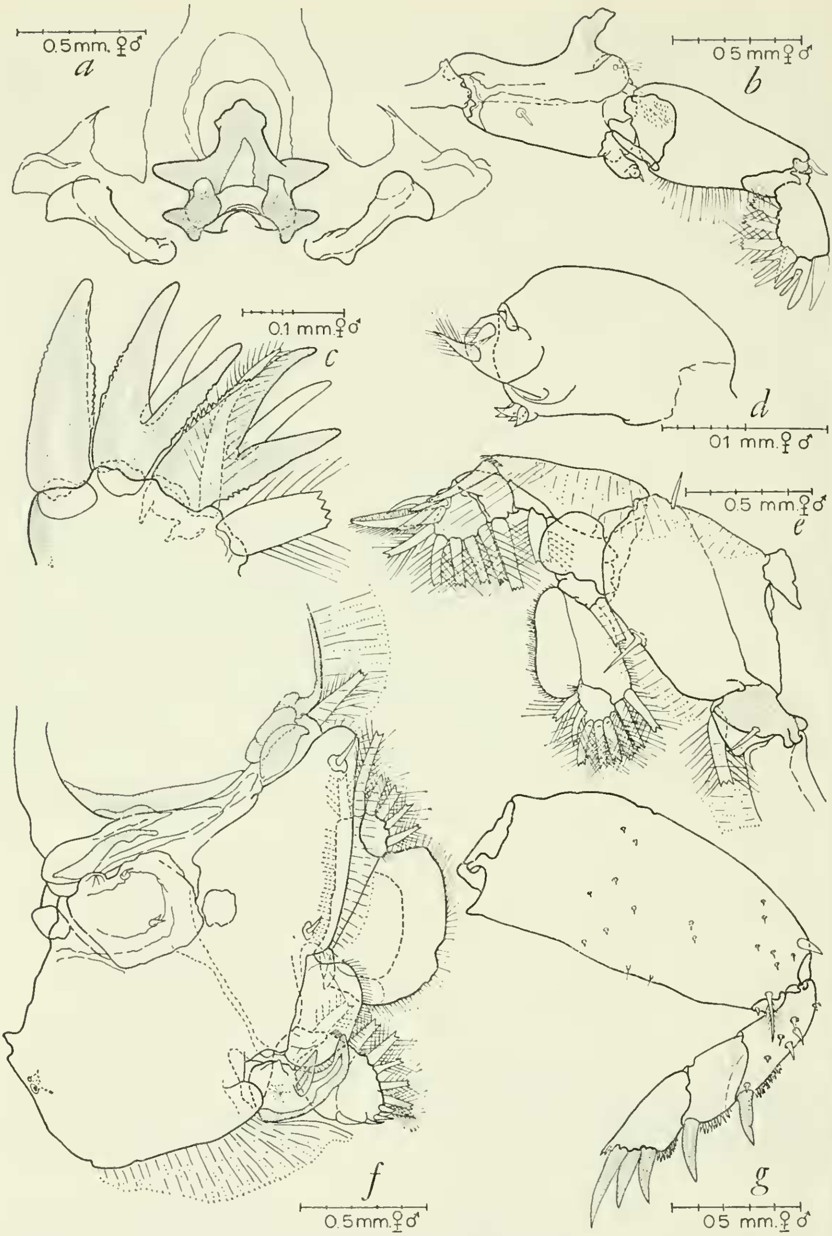


FIGURE 24.—*Gloiopotes huttoni* (Thomson, 1889): *a*, sternal furca, ventral view (male without pads lateral to furca). Thoracic legs, anterior view: *b*, right first; *c*, second segment of exopodite of right first; *d*, endopodite of right first; *e*, right second; *f*, right third; *g*, left fourth.

the process has a single, posteriorly directed spine, an inwardly directed bifid spine, and a single spine arising between the preceding two. In a second female, from the same host specimen, the left postantennal process is similar to that figured by Shiino (1954b, fig. 1*e*) and by Hewitt (1964a, fig. 13), having only the posteriorly directed spine and the bifid inwardly directed spine. In the same female specimen, the postantennal process on the right side has a posteriorly directed spine and a bifid inwardly directed spine, but the tip of the anteriormost tine of the latter is bifid, giving an appearance similar to that shown in figure 23*d* although the bifurcation is not as well developed. Many of the characteristics used to separate the species within the genus *Gloiopotes* have been shown to be variable (Hewitt, 1964a). Hewitt, however (p. 93), states that "the shape of the plates [alae] on the fourth thoracic [fourth pedigerous] segment does not appear to vary but they may be inclined at various angles . . .". The figured female specimen (figs. 22*a*, *c*) exhibits alae with a posterior projection while the alae of some of the other Hawaiian specimens do not have this projection and are rounded posteriorly or are almost flat. It is felt that the use of alae shape as the primary means of distinguishing between species is open to question, as is the use of the inclination of these plates and the amount and position of plumosities on the dorsal surface of the cephalothorax (Hewitt, 1964a). Hewitt also discusses the variation in the number of spines present in the material that he had available for study. This variation is exhibited by the Hawaiian specimens and, from an examination of material in the U.S. National Museum, appears to be characteristic of members of the genus. This author feels that spines may be of value, but only if a complete series is either absent or present (see discussion of *G. ornatus* below). One of the problems in using this characteristic, however, is that many of the spinules or even small spines are not figured or described in the literature (see discussion of *G. auriculatus* below.)

An examination of the type material of *G. costatus* Wilson, 1919 (USNM 49772, 49773, not 51040 and 51041 as Wilson indicates [p. 313]), and other material identified as this species, indicated that the variation that prompted Wilson to erect this species is also found in the Hawaiian specimens of *G. huttoni* (the variation in the number and position of spinules and the shape and inclination of the alae). One of the differences used by Shiino (1954b, p. 278) to separate *G. longicaudatus* (Marukawa) from *G. costatus* Wilson is the tripartite spine figured by Wilson on the first segment of the exopodite of the third leg of *G. costatus*. The female and male cotype specimens used by Wilson for his original description comprised a copulating pair, and the original specimens were in copulo until the present author separated them. An examination of this material suggests that the original figures were made while the pair was in copulo as, among other characteristics, the spine on the first segment of the third leg exopodite is bipartite. An examination of the specimens identified as *G. longicaudatus* by Ho (1963) and deposited in the U.S. National Museum (USNM 111247, 111248) shows the same variation present in the Hawaiian specimens of *G. huttoni* and the variation described by Hewitt (1964a) for the New Zealand specimens of this species.

Based upon these examinations and upon Hewitt's discussion, it is suggested that *G. huttoni* is the species of *Gloiopotes* that is found on billfishes in the Pacific. *G. ornatus* Wilson, 1905b, found on billfishes in the Atlantic, appears to be the counterpart of *G. huttoni* (e.g., Shiino, 1959a). The primary difference between these two species is the presence of a row of spines on the lateral surface of the genital segment of *G. ornatus* (absent in *G. huttoni*).

Barnard (1957) describes a species of *Gloiopotes*, *G. auriculatus*, from a Striped Marlin at Mossel Bay, South Africa. He indicates that it is close to *G. ornatus* Wilson and figures the postcephalothoracic region of both the female and the male. The figure of the female, however, does not show the series of spines on the lateral surface of the genital segment, the diagnostic characteristic for *G. ornatus*. Mossel Bay is at the southern tip of Africa and *G. auriculatus* is bordered on the Indian Ocean side by *G. huttoni* and on the Atlantic side by *G. ornatus*. The association of *G. auriculatus* with the other two species cannot be determined from the literature but offers an intriguing zoogeographical problem.

***Gloiopotes hygomianus* Steenstrup and Lütken**

Figures 25–27

Gloiopotes hygomianus Steenstrup and Lütken, 1861, p. 363, pl. 5, fig. 9.—Bassett-Smith, 1899, p. 458.—Stebbing, 1900, p. 670, pl. 74, fig. A.—Shiino, 1960b, p. 533, figs. 4–6.—Yamaguti, 1963, p. 103, pl. 124, fig. 3.
Gloiopotes species Bonnet, 1948, p. 7.

Distribution and hosts.—4 hosts:

locality	*hosts*	*reference*
Atlantic	Unknown	Steenstrup and Lütken, 1861
Pacific	"Albacore"	Stebbing, 1900
	Acanthocybium solandri	Shiino, 1960b
Hawaii	*Acanthocybium solandri*	Bonnet, 1948

Material.—One female and 1 male (USNM 112881) collected by E. C. Jones (USFWS) from *Acanthocybium solandri* (Cuvier) captured in the Hawaiian area. One female and 1 male (USNM 112882) from the caudal fin of *A. solandri* (Cuvier) captured near the Line Islands

(USFWS). Two females and 1 male (USNM 112883) from *A. solandri* (Cuvier) captured near Washington Island (Line Islands) (USFWS. Two females and 1 male (retained by author) from external surface of *A. solandri* (Cuvier) captured near Fanning Island (Line Islands) (USFWS).

MEASUREMENTS.—(In mm) 6 females and 4 males:

	female		*male*	
	mean	*range*	*mean*	*range*
Total length, excluding caudal setae	14. 33	13. 65–15. 15	9. 92	9. 38–10. 35
Length of cephalothorax, including frontal region	6. 85	6. 68– 7. 13	4. 82	4. 50– 5. 25
Width of cephalothorax	5. 44	5. 25– 5. 78	3. 32	3. 08– 3. 53
Length of genital segment, including posterior projections but not fifth legs	5. 37	4. 73– 6. 15	1. 86	1. 73– 2. 03
Width of genital segment	2. 99	2. 63– 3. 30	1. 63	1. 58– 1. 65
Length of abdomen	3. 15	2. 89– 3. 37	1. 69	1. 52– 1. 78
Length of alae	3. 68	3. 44– 4. 00	1. 56	1. 52– 1. 59
Length of fifth leg, measured along outer margin	1. 51	1. 41– 1. 67	1. 43	1. 30– 1. 52
Length of caudal rami	1. 47	1. 26– 1. 59	1. 57	1. 41– 1. 78
Length of egg strings (4 strings)	12. 32	10. 95–13. 88		

DESCRIPTION.—Female cephalothorax (fig. 25*a*) ovoid, consisting of cephalon and first 4 thoracic segments. Frontal region distinct, with pair of narrow membranes along median anterior edge. Lateral cephalothoracic margins flatly convex, with narrow membrane and row of fine, hairlike plumosities, membrane extending around posterior lateral cephalothoracic regions to beginning of posterior sinus. Posterior sinus ovoid, lateral surface heavily sclerotized, bearing small, posteriorly projecting membrane from posterior half and fine membrane along all of margin, membrane projecting across most of sinus. Anterior end of sinus sharply rounded, with small, lappet-like, posterodorsally projecting membrane; inner surface irregular. Median cephalothoracic region slightly irregular, extending almost to end of lateral cephalothoracic regions. Dorsal surface of posterior lateral cephalothoracic region with row of fine, hairlike plumosities along posterior lateral surface. Dorsal cephalothoracic grooves distinct, forming irregular H although cross groove V-shaped, with apex directed anteriorly; anterior longitudinal grooves of H turning inward sharply just anterior to ocular region. Ocular region small, consisting of 2 darkly pigmented cup-shaped regions contiguous on median longitudinal axis of body, each with spherical lens.

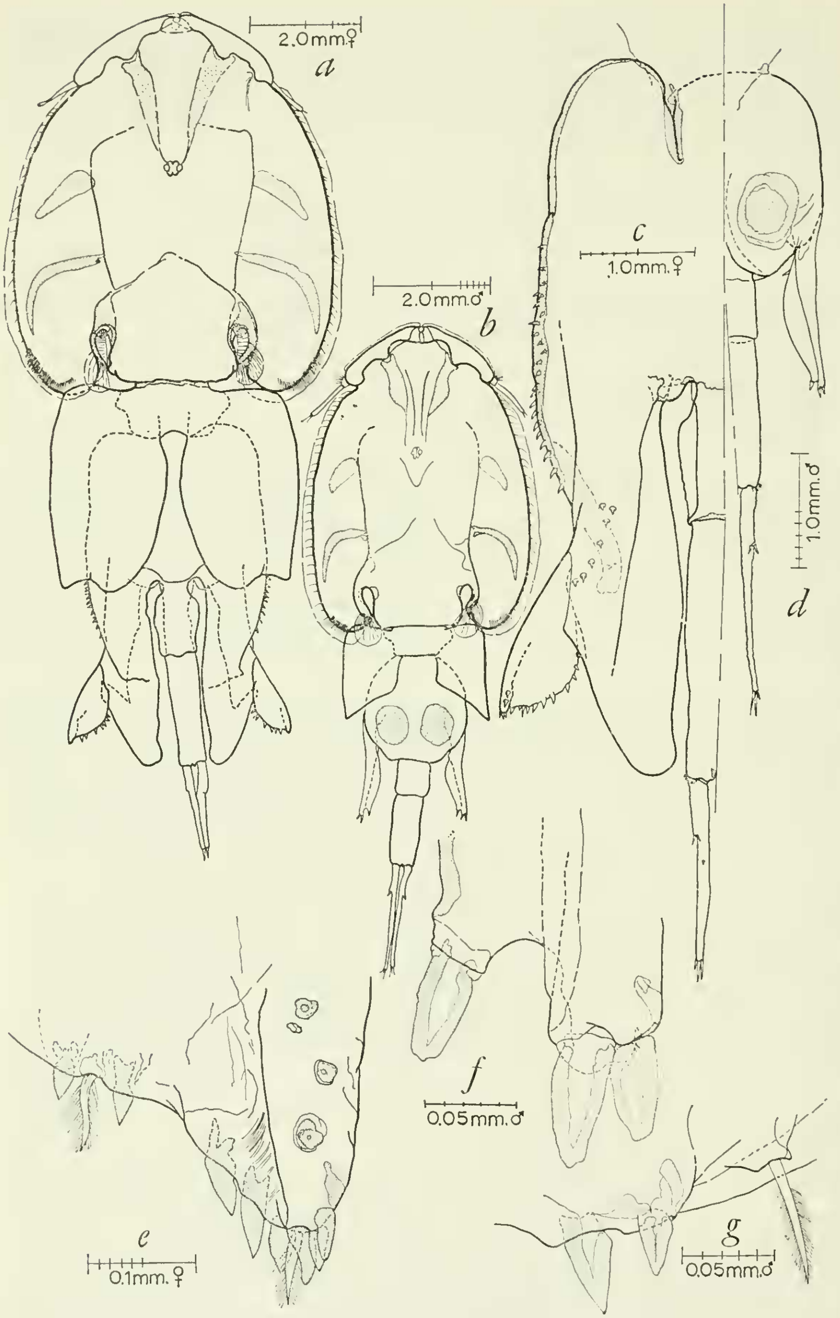


FIGURE 25.—*Gloiopotes hygomianus* Steenstrup and Lütken, 1861, dorsal view: *a*, female; *b*, male. Ventral view: *c*, female genital segment, abdomen, and caudal ramus; *d*, male, same; *e*, tip of female left fifth leg; *f*, male, same; *g*, male left sixth leg.

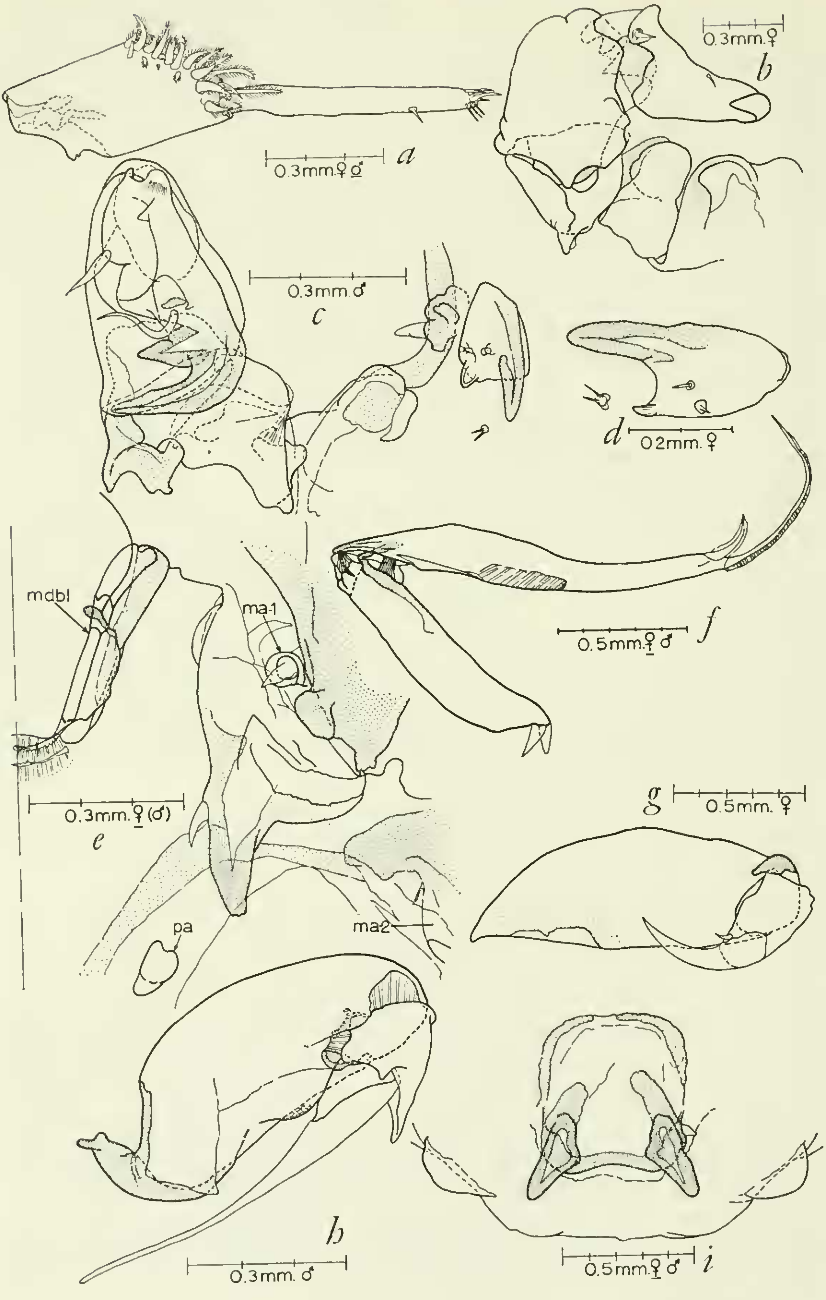
Female free fourth pedigerous segment, excluding ala, slightly more than one-third the width of cephalothorax, indistinctly separable from genital segment. Ala broad, extending laterally past lateral edge of genital segment, with 2 large, subrectangular posterior projections overlapping most of genital segment proper. Apex of sinus between lobes of ala flatly concave, posterior edge of lobes sharply angled laterally, with small, lobate projections medially.

Female genital segment (fig. 25*c*) convex anteriorly, at junction with fourth pedigerous segment, lateral surface smoothly irregular, with row of spinules along posterior two-thirds of segment. Posterior end of segment drawn out into pair of elongate lobes extending posteriorly to end of abdomen, lobes with several rows of spinules and minute spicules (latter not figured). Median lateral surface of lobes also bearing laminate fifth leg projecting laterally and posteriorly. Distal surface of fifth leg (fig. 25*e*) bearing row of spinules and 2 plumose setules.

Female abdomen 2-segmented, incompletely separated from genital segment dorsally and ventrally. First segment slightly more than half the length of second, with distinct dorsal swelling; second segment elongate, tapered slightly toward distal end, with pair of minute spinules on each side in anterior half of segment. Fine frilled membrane present on ventral-lateral posterior surface, at junction with caudal rami. Caudal rami elongate, rodlike, with small lateral indentation in proximal half, indentation bearing 2 plumose setules; distal end with 3 or 4 setules, longer 2 plumose.

Male cephalothorax (fig. 25*b*) generally similar to that of female although more elongate. Apex of posterior sinus without lappet-like membrane although remaining membranes present; cross groove of major dorsal grooves with indistinct apex. Ala of free fourth pedigerous segment with angular posterior edge but without lobes present in female. Male genital segment (fig. 25*d*) more orbicular than that of female, without lappet-like projection but with spikelike fifth leg extending to middle of second abdominal segment, inner dorsal surface of leg projecting medially as narrow, heavily sclerotized flap. Distal end of fifth leg (fig. 25*f*) with 3 spinules, proximal inner surface with minute, plumose setule. Sixth leg (fig. 25*g*) evident as pair of spinules and single minute, plumose setule adjacent to junction of abdomen and genital segment. Abdomen 2-segmented, distinct from genital segment dorsally, indistinctly separable ventrally. Second segment approximately 2½ times the length of first, first without swelling present in female. Caudal rami similar to those of female.

Female and male antennule (fig. 26*a*) 2-segmented, attached to lateral-anterior ventral surface of cephalothorax and adjacent sur-


0.3mm.♀
b
a
0.3mm.♀ ♂
0.3mm.♂
c
d
0.2mm.♀
mdbl
ma-1
f
0.5mm.♀ ♂
g
0.5mm.♀
0.3mm.♀(♂)
e
pa
ma2
h
0.3mm.♂
0.5mm.♀ ♂
i

face of frontal region. First segment slightly shorter than second, broad proximally, narrow distally, distal half of anterior ventral and anterior surfaces with approximately 24 lightly plumose setae and setules. Second segment elongate, rodlike, with single, naked seta from posterior surface in distal third of segment and 8 naked setae from distal surface. Female antenna (fig. 26*b*) 3-segmented, situated medial and posterior to antennule base. Antennal base in close proximity to several flaplike projections of ventral cephalothoracic cuticle. First segment small, subtriangular in ventral view, with spike-shaped projection from posteriormost surface; second segment irregular, outer surface shorter than inner, proximal and distal surfaces irregular. Third segment separable from clawlike terminal process by break in heavy sclerotization, with small, setule-like accessory process proximally, on knoblike projection of segment, and second small, setule-like accessory process at region of break in sclerotization. Male antenna (fig. 26*c*) with irregular first segment, inner proximal surface with heavily sclerotized bifurcation; second segment similar to that of female. Third segment fused with double-clawed terminal process, bearing setule-like accessory process proximally and second, long, setule-like process just proximal to proximalmost claw and arising from slight indentation behind minute, flaplike cuticular projection.

Female and male mandible (fig. 26*e*) 4-parted; first part broad proximally, tapered distally, with flexible joint between first and second parts. Second part short, tapered slightly; third part elongate, approximately equal to combined lengths of first 2 parts. Fourth part short, flattened distally, inner edge of flattened portion with 13 denticulations. Female and male postantennal processes (figs. 26*c*, *d*) consisting of heavily sclerotized plate lateral and slightly posterior to antennal base, with large, spike-shaped projection from lateral surface and small, spike-shaped projection from inner posterior surface; 3 minute nodules present, 2 on plate, third posterior to plate, each with at least 2 hairlike processes. Male with small, flabby, conical projection just medial to inner surface of postantennal process, on ridge of heavy sclerotization extending from lateral anterior margin of cephalothorax to antennal base (fig. 26*c*). Female and male postoral process (fig. 26*e*) large, spinelike, female with small spine arising from inner proximal surface, process absent on male. Female and male maxillule (fig. 26*e*) nodular, with setule distally. Female with pair

FIGURE 26.—*Gloiopotes hygomianus* Steenstrup and Lütken, 1861, ventral view: *a*, left antennule; *b*, female left antenna; *c*, male left antenna and postantennal process; *d*, female right postantennal process; *e*, oral region, left side showing mouth cone, mandible (mdbl), maxillule (ma-1), postoral process, maxilla base (ma-2), and postoral adhesion process (pa); *f*, left maxilla; *g*, female right maxilliped; *h*, male left maxilliped; *i*, sternal furca.

of small, knob-shaped projections posterior to mouth cone base, similar in position to postoral adhesion pads. Female and male maxilla (fig. 26*f*) 2-segmented, situated lateral and posterior to postoral process. First segment approximately two-thirds the length of second, proximal end with pair of subconical articulation projections, segment tapered slightly to distal region. Second segment elongate, broadest medially, with fine membranous flange on inner medial surface, with 2 saber-shaped processes from distal surface, inner more than twice the length of outer, with fine membrane along inner margin, outer with membranes along both margins.

Female maxilliped (fig. 26*g*) 2-segmented, situated posterior and medial to maxilla base. First segment strongly developed; second segment short, distinct from clawlike terminal process, bearing single, setule-like accessory process from inner surface, at junction of segment and terminal process. Male maxilliped (fig. 26*h*) 2-segmented, proximal end of first segment recurved, terminating in socket-shaped articulation surface; segment with slightly roughened adhesion surface on medial inner surface. Second segment appearing bifurcate distally, one ramus of bifurcation formed by scoop-shaped terminal process; segment bearing long, flexible process just proximal to apex of bifurcation. Flexible process longer than first segment, possibly representing elongate accessory process, based on position of origin as well as absence of small, setule-like accessory process present on female.

Female and male sternal furca (fig. 26*i*) situated between and posterior to maxilliped bases, consisting of plate bearing 2 widely separated, bluntly pointed tines and 2 accessory spines, at base of tines. Pair of lappet-like projections present just posterior and lateral to furca.

For nature of armature and legs, see figure 27 and table 10.

TABLE 10.—*Armature of thoracic legs I–IV of the female and male of* Gloiopotes hygomianus *Steenstrup and Lütken, 1861*

Leg	Surface	Inter-podal Plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer		ss,p		h			c	c,2P	
	Inner		p		c	3P,p,3dH			p	
II	Outer	m		m,p'	2m,dH	dH	dH,mH,Q,P	c	c	c,4P
	Inner		s,P	m,s	c,P	c,P	4P	P	c,2P	2P
III	Outer	m	m,p		3s,H	h	3h,2P	c	3P	
	Inner		2s,P,m,2s,c*		P	P	3P	c,2P	P	
IV	Outer‡		p†		d,D,dH	D,dH	D,3fm,3dH			

*Elements between rami.
†Element in middle of segment.
‡Spinules along inner surface not tabulated.

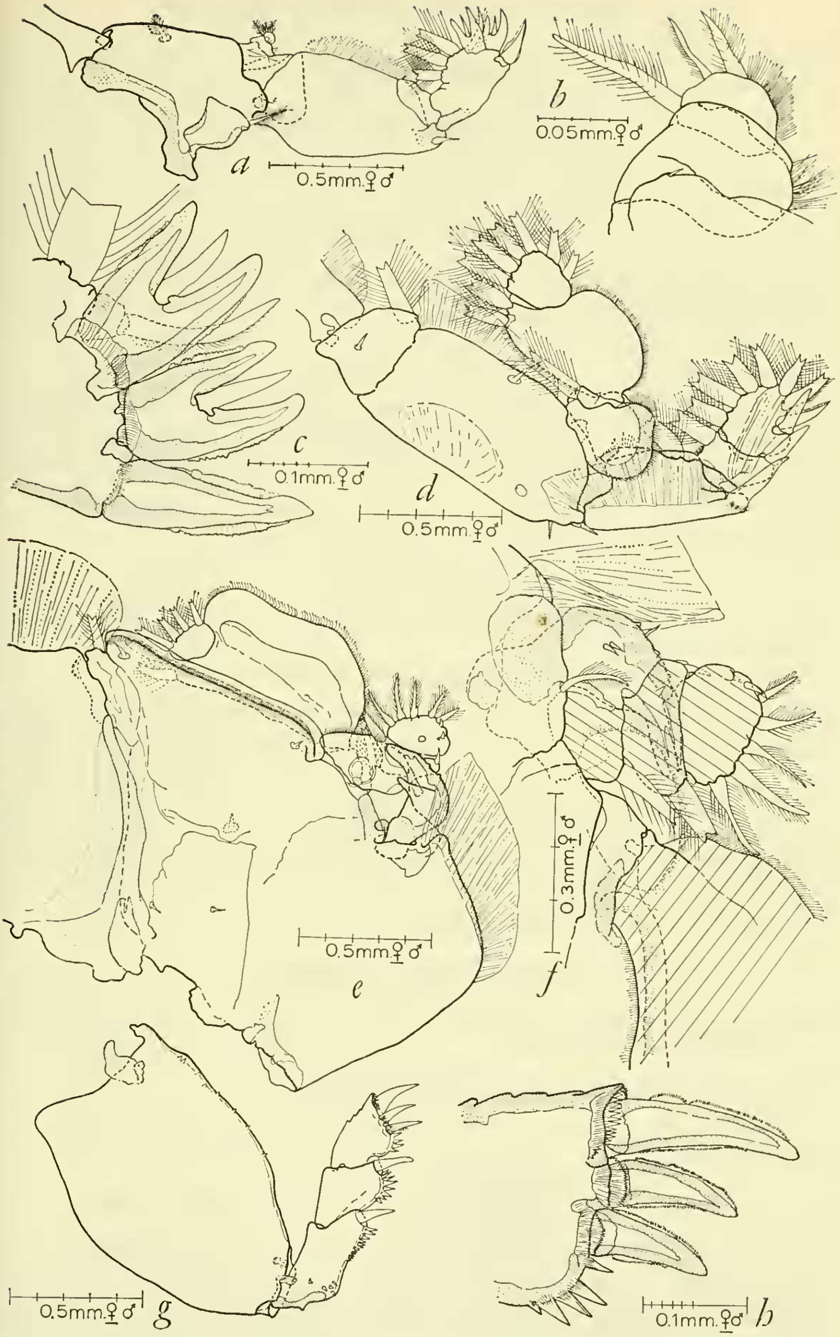


FIGURE 27.—*Gloiopotes hygomianus* Steenstrup and Lütken, 1861, right thoracic legs, anterior view: *a*, first; *b*, endopodite of first; *c*, distal end of second segment of exopodite of first; *d*, second; *e*, third; *f*, exopodite of third (posterior view); *g*, fourth; *h*, distal end of third segment of exopodite of fourth.

Family Caligidae

Dentigryps Wilson, 1913

Diagnosis.—See Lewis, 1964b.

Dentigryps ulua Lewis

Dentigryps ulua Lewis, 1964b, p. 351, figures 2–4; 12a, e, i; 13a.

Hosts and distribution.—1 host record:

location	*hosts*	*reference*
Hawaiian Islands	*Caranx melampygus*?	Lewis, 1964b

Material.—Two females and 1 male (retained by author) from external surface of *Caranx melampygus*? Cuvier and Valenciennes captured in a fishtrap between Diamond Head and Koko Head, Oahu, Hawaii, by Samuel Kaolulo.

Measurements.—(In mm) 2 females and 1 male:

	female	*male*
Total length, excluding fifth legs and caudal setae	6. 60, 6. 83	5. 18
Length of cephalothorax, including frontal region	4. 43, 4. 43	3. 45
Width of cephalothorax	3. 40, 3. 66	2. 92
Length of genital segment, including lobes but excluding fifth legs	1. 67, 1. 67	0. 93
Width of genital segment	1. 70, 1. 70	1. 04
Length of abdomen	0. 61, 0. 76	0. 49
Length of caudal rami	0. 31, 0. 29	0. 29
Length of fifth legs, measured along outer margin	1. 19, 1. 28	0. 99
Length of fifth leg terminal process	0. 05	0. 06
Length of sixth leg, measured along outer margin		0. 15
Length of sixth leg terminal process		0. 14

Description.—See Lewis, 1964b.

Dentigryps bifurcatus Lewis

Dentigryps bifurcatus Lewis, 1964a, p. 203, figs. 17a–c, e–k, m–q; 18a–c, e–f; 1964b, p. 356, figs. 5; 12b, f, j; 13b.

Distribution and hosts.—5 host records:

locality	*hosts*	*reference*
Hawaiian Islands	*Acanthurus olivaceus*	
	A. triostegus sandvicensis	Lewis, 1964a
	Naso hexacanthus	
	Fistularia petimba	Lewis, 1964b

Material.—Three males (retained by author) from external surface of *Bodianus bilunulatus* (Lacépède) from the Honolulu Aquarium. One male (retained by author) from external surface of *Chaetodon fremblii* Bennett captured in a fishtrap by Samuel Kaolulo between Diamond Head and Koko Head, Oahu, Hawaii.

Two immature males (retained by author) from external surface of *Aulostomus chinensis* (Linnaeus) captured in a fishtrap by Samuel Kaolulo between Diamond Head and Koko Head, Oahu, Hawaii.

MEASUREMENTS.—(In mm) 4 males:

Total length, excluding fifth legs and caudal setae	2.15, 2.26, 2.22, 2.29
Length of cephalothorax, including frontal region (N=2)	1.64, 1.62
Width of cephalothorax	1.58, 1.55, 1.48, 1.53
Length of genital segment, excluding fifth legs	0.36, 0.36, 0.36, 0.35
Width of genital segment	0.46, 0.41, 0.41, 0.38
Length of abdomen	0.12, 0.11, 0.11, 0.12
Length of fifth leg, measured along outer margin (N=3)	0.17, 0.19, 0.18
Length of fifth leg terminal process (N=2)	0.04, 0.04
Length of sixth leg, measured along outer margin (N=3)	0.07, 0.09, 0.07
Length of sixth leg terminal process (N=3)	0.09, 0.08, 0.07
Length of caudal rami	0.13, 0.14, 0.13, 0.14

DESCRIPTION.—See Lewis, 1964a.

Anuretes Heller, 1865

DIAGNOSIS.—See Lewis, 1964a.

Anuretes serratus Shiino

Anuretes serratus Shiino, 1954a, p. 260, figs. 1–2.—Lewis, 1964a, p. 188, figs. 13–14.

DISTRIBUTION AND HOSTS.—2 host records:

locality	*hosts*	*reference*
Japan	*Xesurus scalprum*	Shiino, 1954a
Hawaiian Islands	*Naso hexacanthus*	Lewis, 1964a

DESCRIPTION.—See Lewis, 1964a.

Anuretes menehune Lewis

Anuretes menehune Lewis, 1964a, p. 195, figs. 15, 16.

DISTRIBUTION AND HOSTS.—2 host records:

locality	*hosts*	*reference*
Hawaiian Islands	*Naso hexacanthus*	
	N. unicornis	Lewis, 1964a

DESCRIPTION.—See Lewis, 1964a.

Lepeophtheirus Nordmann, 1832

DIAGNOSIS.—Cephalothorax consisting of cephalon and first 4 thoracic segments; frontal region distinct, without lunules. Free fourth pedigerous segment without alae. Genital segment without projecting plates; fifth legs present on female and male, setiform or projecting slightly, without ornamentation; sixth legs present on male, setiform. Abdomen 1–2 segmented. Antennule 2-segmented, antenna 3-segmented, with clawlike terminal process and frequently, in male, with adhesion or additional spinelike process. Mandible rodlike, distal region flattened, with 12 denticulations on distal inner surface. Postantennal process consisting of 3 nodules, each with several hairlike processes, and clawlike projection; postoral process spinelike, often with smaller, spinelike secondary projection on inner surface in male. Maxillule nodular, with setule-like processes; maxilla 2-segmented, with 2 saber-like terminal processes. Sternal furca present. Thoracic legs I–III biramous although endopodite of first legs rudimentary; fourth legs uniramous, typically with 4 segments.

Lepeophtheirus crassus (Wilson and Bere)

Figures 28–30

Gloiopotes crassus Wilson and Bere, *in* Bere, 1936, p. 590, pl. 5, figs. 109–111; pl. 6, figs. 125–155.

Lepeophtheirus crassus (Wilson and Bere) Shiino, 1960c, p. 546, figs. 3–4.—Yamaguti, 1963, p. 72.—Shiino, 1963a, p. 337, fig. 2.

Distribution and hosts.—4 host records:

locality	*hosts*	*reference*
Western Atlantic	*Rhombochirus osteochir*	Wilson and Bere, 1936
Eastern Pacific	"Remora"	
	Remilegia australis	Shiino, 1963a
Indian Ocean	*Echeneis albescens*	Shiino, 1960c

Material.—Five females (USNM 112884) from external surface of *Rhombochirus osteochir* (Cuvier) taken from *Tetrapturus angustirostris* Tanaka captured by longline at 21°04.5′N, 173°47.5′E (USF WS). Two females and 1 male (USNM 112885) from external surface of *Rhombochirus osteochir* (Cuvier) taken at 20°50.5′N, 167°34.5′E.

Remarks.—Although these specimens were taken well west of the Hawaiian Islands, the hosts are found in the Hawaiian area. Based upon this and the wide reported distribution of the copepod, the author feels that the copepod is a member of the Hawaiian parasitic copepod fauna.

Measurements.—(In mm) 7 females and 1 male:

	female		*male*
	mean	*range*	
Total length, excluding caudal setae	6. 36	5. 63–7. 05	4. 80
Length of cephalothorax, including frontal region	3. 73	3. 53–4. 20	3. 00
Width of cephalothorax	3. 07	2. 70–3. 38	2. 48
Length of genital segment, excluding fifth legs	1. 69	0. 98–2. 06	0. 82
Width of genital segment	1. 91	1. 50–2. 18	0. 75
Length of abdomen	0. 81	0. 53–0. 98	0. 53
Length of fifth leg, excluding setae	0. 79	0. 72–0. 86	0. 40
Length of fifth leg subterminal seta (female N=6)	0. 08	0. 07–0. 11	0. 04
Length of egg strings (4 strings)	2. 83	2. 63–3. 15	

Description.—Female cephalothorax (fig. 28*a*) ovoid, consisting of cephalon and first 4 thoracic segments. Frontal region narrow,

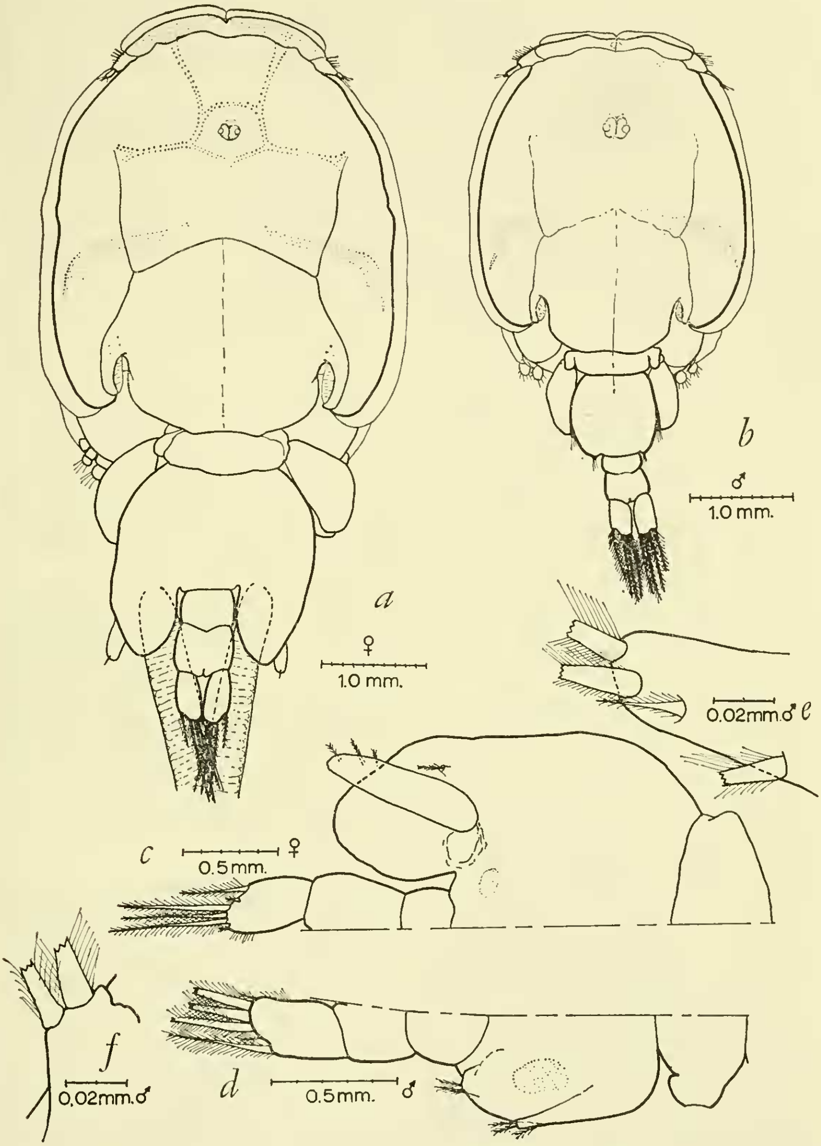


Figure 28.—*Lepeophtheirus crassus* (Wilson and Bere, 1936), dorsal view: *a*, female; *b*, male. Ventral view: *c*, female genital segment, fifth leg, abdomen, and caudal ramus; *d*, male, same; *e*, male tip of fifth leg; *f*, male sixth leg.

anterior edge with median indentation and narrow, membranous flange. Lateral margins of cephalothorax flatly convex except for slight medial swelling, posterior lateral corners smoothly rounded, lateral surface terminating just lateral to beginning of posterior cephalothoracic sinuses, at origin of longitudinal legs of cephalothoracic grooves. Posterior sinuses distinct, U-shaped, lateral margin heavily sclerotized, bearing filmy membrane that projects into sinus. Posterior margin of median cephalothoracic region with slight concavity medially, lateral margins convex. Major cephalothoracic grooves forming irregular H, posterior longitudinal legs forming line of division between median and lateral cephalothoracic regions. Cross groove of flattened V-shape, apex pointing anteriorly. Anterior longitudinal grooves extending anteriorly and slightly laterally to indistinct termination lateral and slightly posterior to ocular region. Ocular region distinct, consisting of 2 heavily pigmented cup-shaped regions, contiguous on median longitudinal axis of body, each with spherical lens. Small, heavily pigmented area present between posterior ends of cup-shaped regions and small, heavily sclerotized V-shaped region present at anterior end of eyes, apex of V extending into depression formed by inner anterior margins of cup-shaped pigmented region.

Female free fourth pedigerous segment short, width more than twice the length. Dorsal surface heavily sclerotized, medial posterior margin of segment distinct dorsally, flatly convex.

Lateral margins of genital segment (fig. 28*c*) flatly convex, posterior lateral surfaces forming lobate projections extending posteriorly almost to end of second segment of abdomen. Fifth legs originating on posterior ventral surface, just lateral to oviducal opening, at base of lobate projections. Fifth legs dactyliform although slightly irregular, not heavily sclerotized, extending posteriorly past posterior end of lobate projection, bearing 3 plumose setules on dorsal surface in distal third of leg; additional plumose setule present on ventral surface of genital segment, just lateral to leg base.

Abdomen 2-segmented, distinct from genital segment. First segment approximately four-fifths the length of second, lateral margins flatly convex, posterior margin convex ventrally, V-shaped dorsally, overlapping anterior end of second segment. Lateral margins of second segment flatly convex, posterior margin slightly irregular, tapered to bilobed anal region. Caudal rami laminate, length slightly less than twice the width. Both lateral margins flatly convex, inner lateral surface plumose distally. Outer distal margin indented, bearing single plumose seta; inner two-thirds of distal surface rounded, bearing 4 plumose setae; knoblike projection present on inner distal surface, bearing minute, spikelike terminal process.

Cephalothorax of male (fig. 28*b*) generally similar to that of female. Anterior margin of frontal region flatter than in female; V-shaped region of heavy sclerotization at anterior end of ocular region also flatter. Free fourth pedigerous segment as in female. Genital segment (fig. 28*d*) slightly longer than wide, lateral margins flatly convex, posterior surface of segment overlapping dorsal surface of first abdominal segment slightly. Fifth legs dactyliform, originating on anterior-medial ventral surface, extending posteriorly and slightly laterally to posterior medial region of genital segment. Fifth legs with 2 plumose terminal setules, one plumose subterminal setule, and one plumose setule from outer dorsal surface approximately two-thirds the distance from proximal to distal end of leg (fig. 28*e*). Sixth legs (fig. 28*f*) small, somewhat irregular, projecting slightly from posterior-lateral ventral surface of segment and tipped by 2 plumose setules. Abdomen 2-segmented, similar to that of female except dorsal posterior projection of first segment not as distinct. Caudal rami somewhat more rectangular in shape than those of female, otherwise similar.

Female and male antennule (fig. 29*a*) 2-segmented; first segment more than twice the length of second, proximal margin broad, irregular, with several small concavities and projections, one concave depression in posterior margin forming articulation surface for small, knoblike projection of platelike area on anterior ventral surface of cephalothorax. Anterior lateral margin of first segment convex, posterior lateral margin almost straight except distally where posterior lateral surface forms base of small, shelflike extension of distal surface; distal surface narrow, irregular. Anterior and distal ventral surfaces with at least 14 plumose setae. Second segment club shaped, ovoid in cross section, narrow proximally and distally, widest medially. Distal medial region of posterior surface with one naked seta, distal surface with 11 naked setae and one spikelike process, on anterior distal corner. Female antenna (fig. 29*b*) 3-segmented, located posterior and slightly medial to antennule base. First segment irregular, proximal end narrow, distal medial region broad, bearing posteriorly projecting lobe; second segment strongly developed, slightly shorter than first segment, greatest width slightly more than four-fifths the length, distal corner projecting slightly as heavily sclerotized, rounded process (not figured). Third segment and clawlike terminal process continuous, proximal posterior surface with small, poorly developed, laminate lobe. Setalike accessory process present on middle of combined segment and terminal process, presumably at junction of segment and terminal process. Male antenna (fig. 29*c*) 3-segmented; first segment flattened, median third forming adhesion surface. Second segment well developed, longer than first segment, most of proximal inner surface forming adhesion surface, inner distal surface with 2 heavily sclerotized swellings serving as articulation surfaces for 2 swellings on inner proximal surface of

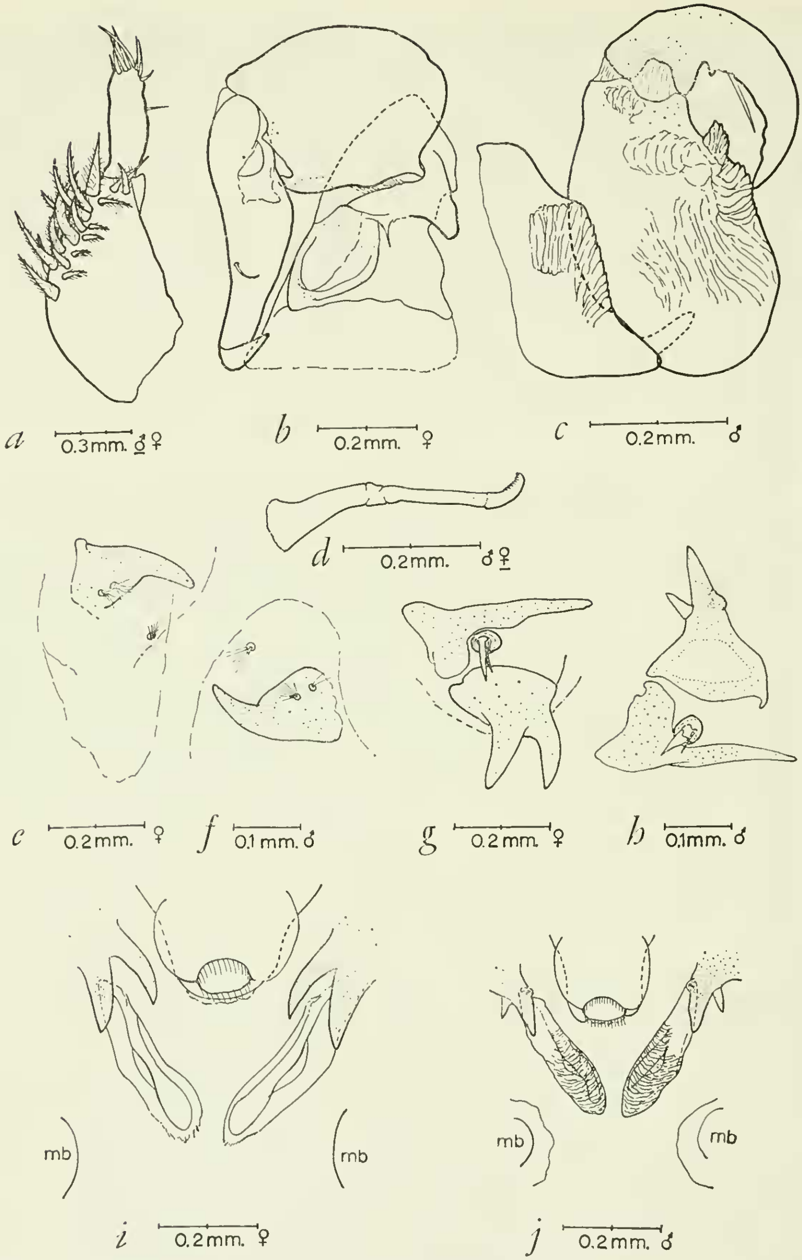


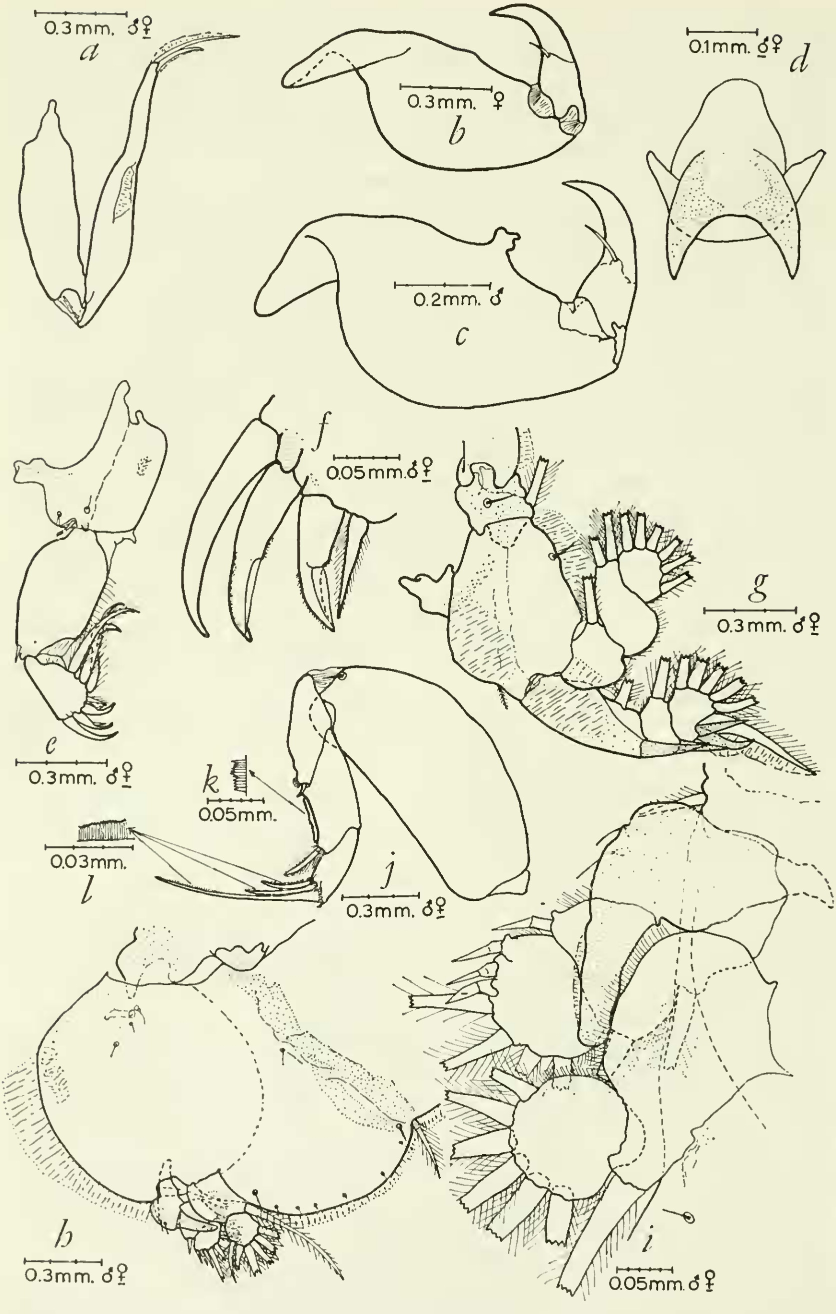
FIGURE 29.—*Lepeophtheirus crassus* (Wilson and Bere, 1936), ventral view: *a*, left antennule; *b*, female right antenna; *c*, male, same; *d*, right mandible; *e*, female left postantennal process; *f*, male, same; *g*, female right maxillule and postoral process; *h*, male, same; *i*, female postoral adhesion pads, postoral processes, posterior end of mouth cone and maxilliped bases (mb); *j*, male, same.

third segment; posteriormost swelling on second segment with small, slightly projecting adhesion surface. Third segment and terminal process continuous, claw shaped, inner surface irregular, appearing roughened or minutely denticulated distally; single, long, needle-like accessory process present on inner surface just distal to small swelling on proximal medial region of segment.

Female and male mandible (fig. 29*d*) 4-parted, fourth part short, curved inward smoothly, bluntly rounded distally, inner margin with 12 denticulations although proximal 2 denticulations indistinct in some specimens. Female postantennal process (figs. 29*e, f*) consisting of platelike region of heavy sclerotization bearing spikelike projection and 3 nodules, each nodule with several hairlike processes; spikelike projection broad proximally, tapering sharply in proximal half, gradually in distal half, curving medially sharply in male, slightly in female, sharply rounded, or pointed, distally. Female postoral process (fig. 29*g*) bifurcate, both tines pointed; male postoral process (fig. 29*h*) spinelike, with small spine projecting from middle of outer surface and small, heavily sclerotized swelling on middle of inner surface. Female and male maxillule (figs. 29*g, h*) nodular, with 3 setules distally. Female and male maxilla (fig. 30*a*) 2-segmented, situated just lateral and posterior to postoral process. First segment approximately three-fourths the length of second, slender, lateral margins almost parallel; second segment elongate, widest medially, medial region with fine membrane and, in male, small, spinelike projection just distal to membrane. Distal end of second segment with 2 saber-shaped, flexible processes, innermost approximately 1½ times the length of outermost, inner bearing fine membrane on inner surface, outer with denticulated, membrane-like process along outer margin. Male with pair of ovoid adhesion surfaces (fig. 29*f*) extending posteriorly and medially from just posterior to postoral processes to just anterior to maxilliped bases, surfaces distinctly rugose. Female also with surfaces but not rugose (fig. 29*i*).

Female maxilliped (fig. 30*b*) 2-segmented, situated posterior and slightly medial to maxilla base. First segment strongly developed, proximal end lobate, extending into cephalothorax as articulation and muscle attachment surface. Second segment and terminal process continuous, length of segment and process slightly greater than half that of first segment, terminal process clawlike, sharply pointed; single small, setalike accessory process present on inner surface at irregular division between segment and terminal process. Male maxilliped (fig. 30*c*) similar to that of female although small, irregular protrusion present on medial inner surface of first segment, protrusion receiving distal end of second segment terminal process when

226-321—67——6


0.3mm. ♂♀
a
0.3mm. ♀
b
0.1mm. ♂♀
d
0.2mm. ♂
c
f
0.05mm. ♂♀
e
0.3mm. ♂♀
g
0.3mm. ♂♀
k
0.05mm.
0.03mm.
l
j
0.3mm. ♂♀
h
0.3mm. ♂♀
i
0.05mm. ♂♀

segment flexed. Terminal process of second segment not as sharply curved as in female, accessory process slightly longer.

Female and male sternal furca (fig. 30*d*) situated about halfway between maxilliped bases and interpodal plate of first thoracic leg. Process consisting of ovoid, heavily sclerotized plate with 2 winglike anterolaterally projecting structures in addition to U-shaped furca. Tines of furca either pointed or sharply rounded, outer margins flatly convex.

For nature of legs and armature, see figure 30 and table 11.

TABLE 11.—*Armature of thoracic legs I–IV of the female and male of* Lepeophtheirus crassus (*Wilson and Bere, 1936*)

Leg	Surface	Interpodal Plate	Protopodite 1	Protopodite 2	Exopodite 1	Exopodite 2	Exopodite 3	Endopodite 1	Endopodite 2	Endopodite 3
I	Outer		ss,p		rh	3H,P				
	Inner		p		c	3P				
II	Outer	m		m,p	m,fmH	fmH	H,qH,Q,2P	c	c	c,3P
	Inner		s,P	m,s	c,P	c,P	c,3P	P	c,2P	c,3P
III	Outer	m	m,P		3s	c,p′	c,3p′,P	c	c,2p	
	Inner		P,s,m,11s*		p,mH	c,P	c,3P	P	c,4P	
IV	Outer		s		dm,h	dm,fmH	3dm,3fmH			

*On both anterior and posterior surfaces of protopodite.

Lepeophtheirus dissimulatus Wilson

Lepeophtheirus dissimulatus Wilson, 1905b, p. 631, pl. 22.—Lewis, 1963, p. 195, figs. 1–20; 1964a, p. 178, figs. 11–12. [For synonymy, see Lewis, 1964a.]

REPORTED DISTRIBUTION AND HOSTS.—24 host records:

locality	*hosts*	*reference*
Bermuda	*Epinephalus morio*	Wilson, 1905b
	E. striatus	
	Mycteroperca apua	Linton, 1907
	Thynnus pelamys	Heegaard, 1943b
Dry Tortugas	*Lactophrys triqueter*	Wilson, 1935b
Galapagos Islands	*Epinephelus labriformis*	Wilson, 1905b
	Mycteroperca species	Heegaard, 1943b
Eastern Pacific	*Bodianus diplotaenis*	
	Epinephelus labrifrons	Shiino, 1959d
	Merluccius productus	
	Paralichthys californicus	
	Hypsopsetta guttulata	
	Sphyraena argentea	

FIGURE 30.—*Lepeophtheirus crassus* (Wilson and Bere, 1936), lateral view: *a*, maxilla; *b*, female maxilliped; *c*, male maxilliped; *d*, sternal furca (ventral view). Right thoracic legs, anterior view: *e*, first; *f*, second segment of exopodite of first; *g*, second; *h*, third; *i*, exopodite and endopodite of third; *j*, fourth; *k*, frilled membrane on second segment of exopodite of fourth; *l*, frilled membrane on terminal spines of third segment of exopodite of fourth.

locality	*hosts*	*reference*
	Paralabrax nebulifer	
	Sphaeroides annulatus	
	Galeichthys guatemalensis	Causey, 1960
	Gadus macrocephalus	Lewis, 1964a
Hawaii	*Acanthurus olivaceus*	
	A. dussumieri	
	A. triostegus sandivcensis	
	Zebrasoma flavescens	
	Naso hexacanthus	
	Chaetodon quadrimaculatus	Lewis, 1964a
Mauritania	*Labrus* species sensu lato	Brian, 1924

Material.—Four females and 4 males (retained by author) from gill cavity of *Parupeneus pleurostigma* (Bennett) captured in fishtrap by Samuel Kaolulo between Diamond Head and Koko Head, Oahu, Hawaii. One female and 1 male (retained by author) from external surface of *P. pleurostigma* (Bennett) captured by trap by Samuel Kaolulo between Diamond Head and Koko Head, Oahu, Hawaii.

Measurements.—(In mm) 4 females and 5 males:

	female		*male*	
	mean	*range*	*mean*	*range*
Total length, excluding caudal setae	2. 66	2. 53–2. 75	2. 17	2. 03–2. 25
Length of cephalothorax, including frontal region	1. 78	1. 75–1. 83	1. 60	1. 52–1. 75
Width of cephalothorax	1. 68	1. 65–1. 70	1. 43	1. 40–1. 45
Length of genital segment	0. 60	0. 53–0. 68	0. 36	0. 34–0. 38
Width of genital segment	0. 86	0. 78–0. 95	0. 35	0. 35 (all)
Length of abdomen	0. 13	0. 12–0. 14	0. 11	0. 10–0. 12
Length of caudal rami	0. 08	0. 07–0. 09	0. 10	0. 08–0. 11
Length of egg strings (2 strings)	1. 00, 1. 48			

Description.—See Lewis, 1964a.

Lepeophtheirus? fallolunulus, new species

Figures 31–33

Material.—One female (holotype, USNM 112886) from the gill cavity of *Naso unicornis* (Forskål) speared off Lehua Rock, Niihau, Hawaii. One immature adult male (allotype, USNM 112887) from buccal cavity of *Naso unicornis* (Forskål) speared near "the blowhole," Oahu, Hawaii.

Measurements.—(In mm) 1 female and 1 male:

	female	*male*
Total length, excluding caudal setae	3. 05	2. 25
Length of cephalothorax, including frontal region	1. 43	1. 30
Width of cephalothorax	1. 30	1. 23
Length of genital segment	1. 08	0. 54
Width of genital segment	0. 85	0. 45
Length of abdomen	0. 15	0. 14
Length of caudal rami	0. 07	0. 08
Length of egg strings	1. 20	

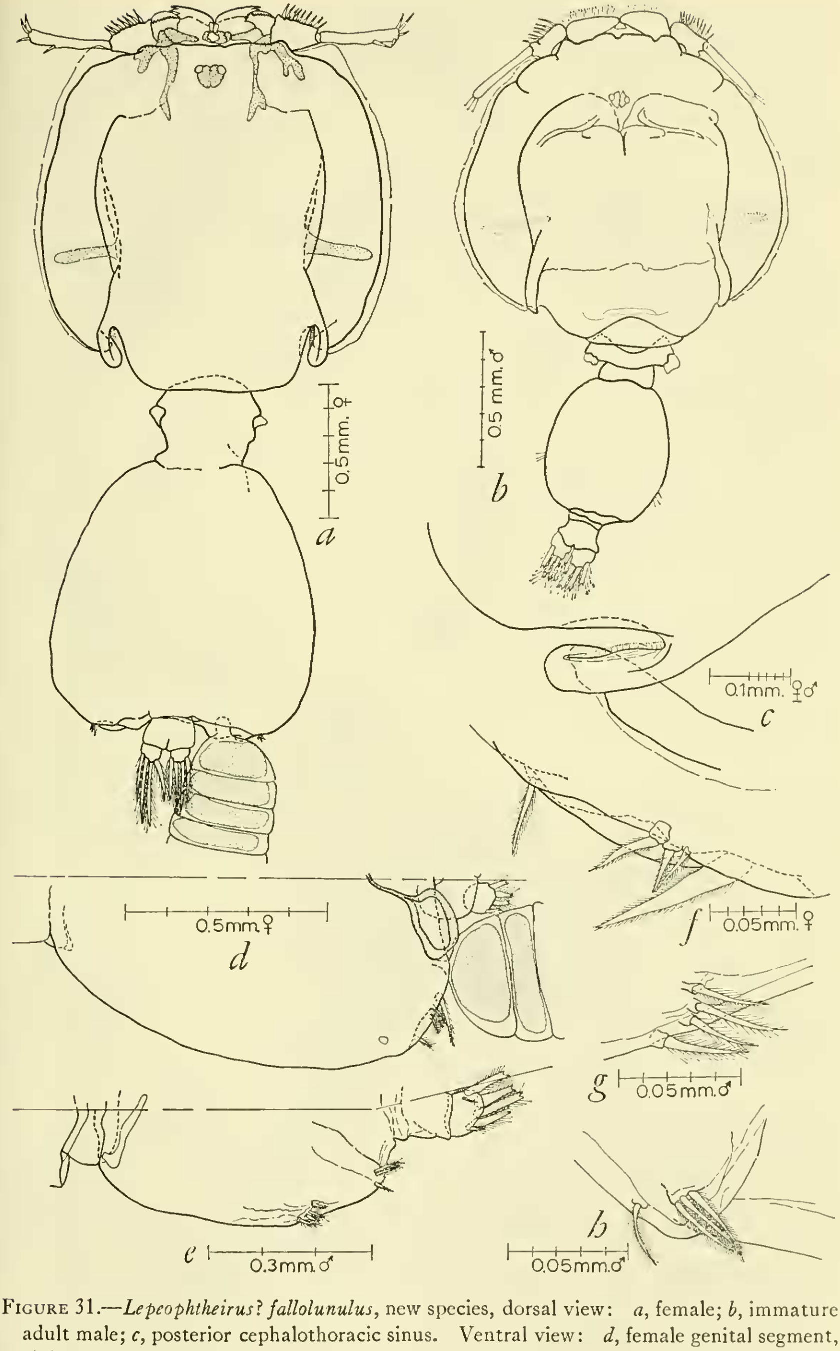
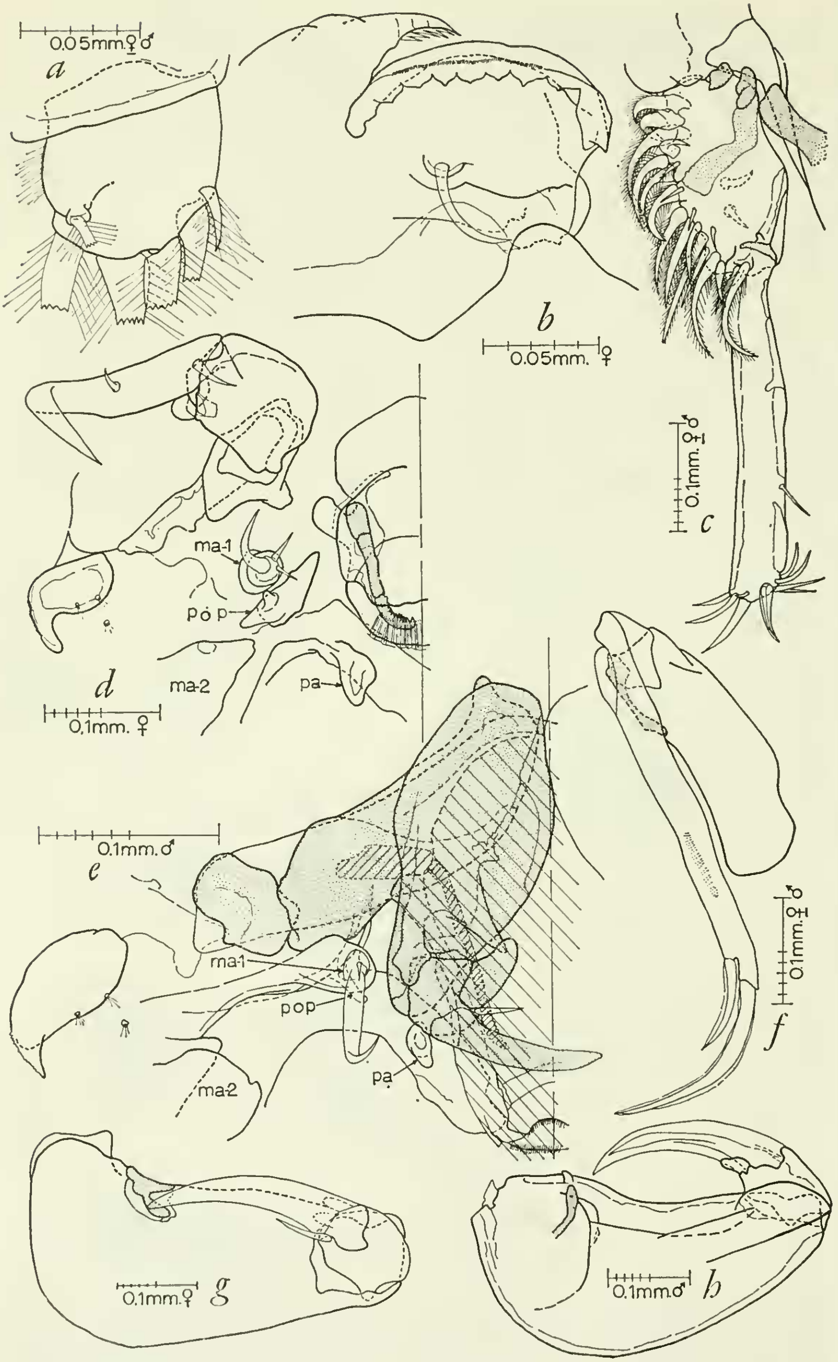


Figure 31.—*Lepeophtheirus? fallolunulus*, new species, dorsal view: *a*, female; *b*, immature adult male; *c*, posterior cephalothoracic sinus. Ventral view: *d*, female genital segment, abdomen, and caudal ramus; *e*, male, same; *f*, female right fifth leg; *g*, male, same; *h* male right sixth leg.


0.05mm. ♀ ♂
a
b
0.05mm. ♀
0.1mm. ♀ ♂
c
ma-1
po p
pa
ma-2
d
0.1mm. ♀
0.1mm. ♂
e
ma-1
pop
pa
ma-2
0.1mm. ♀ ♂
f
0.1mm. ♀
g
0.1mm. ♂
h

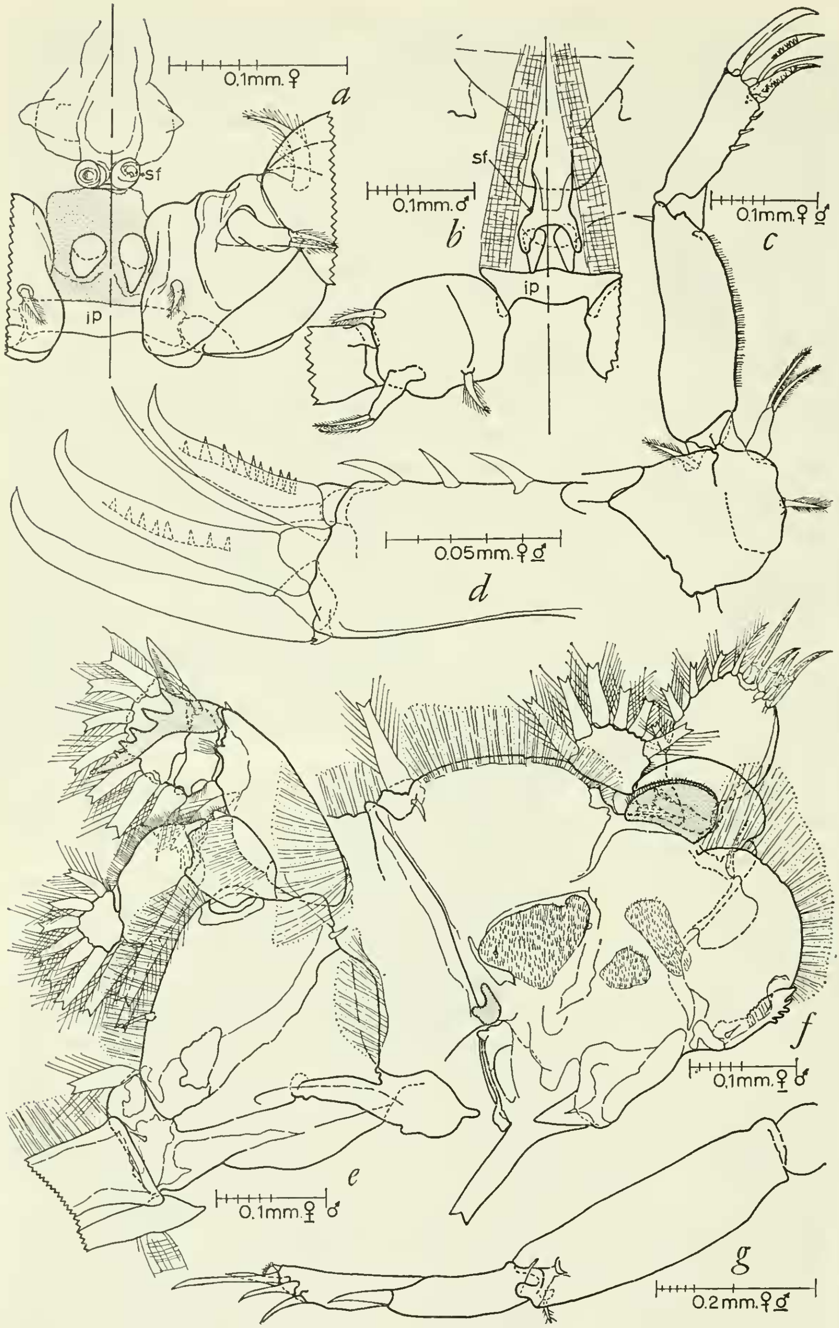
Description.—Female cephalothorax (fig. 31*a*) oblong, consisting of cephalon and first 4 thoracic segments. Frontal region with dorsally facing lunule-like modification laterally, with deep incision medially and fine membrane along anterior ventral surface median to modification. Lunular modifications (fig. 32*b*) with denticulated, dorsally facing anterior margin, bearing single setule posteriorly. Division between frontal region and cephalothorax distinct; 2 large, subtriangular projections present, extending anteriorly to posterior region of lunular modifications from origin on lateral anterior surface of cephalothorax. Posterior two-thirds of median cephalothoracic region raised dorsally, above lateral cephalothoracic regions. Lateral surface of cephalothorax forming distinct flange ventrally, bearing fine membrane along entire length. Posterior sinus (fig. 31*c*) distinct, slender, with heavily sclerotized lateral surface, bearing fine membrane along outer surface. Posterior end of median cephalothoracic region extending well past posterior end of lateral regions, covering anterior end of free fourth pedigerous segment. Major dorsal cephalothoracic grooves running longitudinally, cross groove absent. Free fourth pedigerous segment slender, without dorsal plates.

Female genital segment (fig. 31*d*) ovoid, indistinctly separable from free fourth pedigerous segment. Posterior end of segment irregular, irregularities primarily in region of oviducal openings. Fifth leg (fig. 31*f*) consisting of 5 plumose setules on lateral ventral surface just lateral to oviducal opening.

Female abdomen 1-segmented, distinct from genital segment. Caudal rami subrectangular, irregular distally, inner surface plumose; distal region with 4 plumose setae and 2 plumose setules.

Male cephalothorax (fig. 31*b*) differing from female in shape (circular), in absence of lunular modification of frontal region, in absence of deep median incision of frontal region, in membrane projecting from anterior edge of frontal region instead of from anterior ventral surface. Also differing in concave nature of posterior median cephalothoracic region, with large, lappet-shaped projection extending over anterior half of free fourth pedigerous segment and forming attachment surface of segment. Median cephalothoracic region with fine cuticular extension dorsally, extension covering concave posterior margin of region and most of lappet-shaped projection. Free fourth pedigerous

Figure 32.—*Lepeophtheirus? fallolunulus*, new species, ventral view: *a*, left caudal ramus; *b*, female frontal region, right side showing lunule-like structure (dorsal view); *c*, right antennule; *d*, female oral region, right side showing antenna, postantennal process, mouth cone, mandible, maxillule (ma-1), postoral process (pop), postoral adhesion process (pa), and maxilla base (ma-2); *e*, male oral region, right side showing antenna (stippled), postantennal process, mouth cone (hatched), mandible (hatched), maxillule (ma-1), postoral process (pop), postoral adhesion process (pa) and maxilla base (ma-2); *f*, right maxilla; *g*, female left maxilliped; *h*, male right maxilliped.



0,1mm. ♀
a
sf
ip
0,1mm. ♂
b
sf
ip
0,1mm. ♀ ♂
c
0.05mm. ♀ ♂
d
0,1mm. ♀ ♂
e
0,1mm. ♀ ♂
f
0.2mm. ♀ ♂
g

segment without plates. Segment-like projection present between fourth pedigerous and genital segments, separable from fourth pedigerous segment (at least superficially) both dorsally and ventrally, distinct from genital segment; projection without processes. Genital segment (fig. 31*e*) barrel shaped, fifth and sixth legs (figs. 31*g*, *h*) evident as series of plumose setules. Abdomen 1-segmented although with annulations anteriorly. Caudal rami as in female.

Female and male antennule (fig. 32*c*) 2-segmented, attached to ventral surface of subtriangular projection from lateral anterior surface of cephalothorax. Anterior and distal ventral surface of first segment with 20 plumose setae and setules, median dorsal surface with 2. Distal-medial posterior surface of elongate second segment with single naked setule, distal surface with 10. Female antenna (fig. 32*d*) 3-segmented, situated posterior to subtriangular projection associated with antennule and frontal region. First segment short, irregular, attached to laterally extending, heavily sclerotized ridge. Third segment fused with clawlike terminal process, bearing 2 setule-like accessory processes. Male antenna (fig. 32*e*) 3-segmented, first segment originating on heavily sclerotized ridge, extending medially and ventrally so that second segments of both antennae in close proximity to each other. Second segment club shaped, with 1 large and 1 small, spinelike projection on inner ventral surface. Third segment short, distinct from long, saber-shaped terminal process, shorter, spinelike subterminal process and setule-like accessory process.

Female and male mandible (figs. 32*d*, *e*) 4-parted, rodlike, distal part curving inward, inner surface with 12 denticulations. Female and male postantennal process (figs. 32*d*, *e*) consisting of sharply curved, spinelike process, with outer margin denticulated distally, in addition to 3 nodules, 2 on base of spinelike process, third posterior to process, each with several hairlike processes. Female postoral process (fig. 32*d*) formed of heavily sclerotized plate bearing small bifurcate projection, tines rounded distally. Male postoral process (fig. 32*e*) small, lappet-like projection of heavily sclerotized ridge. Female maxillule (fig. 32*d*) nodular, with 3 setules distally; male maxillule (fig. 32*e*) nodular, with 1 long and 1 short setule distally. Male oral region well anterior and congested, mouth cone located between projecting first segments of antennae; postoral process, antenna base, mouth cone, maxillule, and maxilla in close proximity.

FIGURE 33.—*Lepeophtheirus? fallolunulus*, new species, ventral view: *a*, female sternal furca (sf), tinelike projections, and base of first thoracic legs (ip=interpodal plate); *b*, male sternal furca (sf), tinelike projections, and first thoracic legs (ip=interpodal plate). Right thoracic legs: first, posterior view; *d*, second segment of exopodite of first, posterior view; *e*, second, anterior view; *f*, third, anterior view; *g*, fourth, posterior view.

Small, heavily sclerotized, knoblike postoral adhesion process present in both female and male (figs. 32*d*, *e*), arising from Y-shaped region of heavy sclerotization, just posterior to postoral process. Female and male maxilla (fig. 32*f*) 2-segmented, second segment with fine membrane along medial posterior surface and 2 saber-shaped terminal processes, innermost approximately twice the length of outermost.

Female and male maxilliped (figs. 32*g*, *h*) 2-segmented, situated medial and posterior to maxilla base. First segment strongly developed, with indentation on proximal inner surface, identation with pair of small, heavily sclerotized projections, adjacent surfaces of projections forming groove receiving distal end of second segment terminal process when second segment flexed. Second segment separable from clawlike terminal process, bearing setalike and lappet-shaped accessory processes.

Sternal furca (figs. 33*a*, *b*) situated well posterior to maxilliped bases. Bifurcate portion of female furca at end of necklike process, bifurcate portion of male furca also on process although process much shorter. Pair of spinelike projections present, posterior to furcal base, just anterior to interpodal plate of first thoracic legs.

For nature of legs and armature, see figures 33*c–g* and table 12. First thoracic leg with 3 spinules on inner surface of second segment of exopodite instead of 3 plumose setae normally found.

TABLE 12.—*Armature of thoracic legs I–IV of the female and male of* Lepeophtheirus? fallolunulus, *new species*

Leg	Surface	Interpodal Plate	Protopodite 1	Protopodite 2	Exopodite 1	Exopodite 2	Exopodite 3	Endopodite 1	Endopodite 2	Endopodite 3
I	Outer		p		rh	H,2dH,P′		p′		
	Inner		p		C	3rh		p′		
II	Outer	m		m,p	m,H‡	h	h,mh,Q,2P	C	c	c,3P
	Inner		s,P	m,p′	c,P	c,P	3P	P	c,2P	3P
III	Outer	m	D†,s,a*,m,p		H	P,p,2P		c	c,3P	
	Inner		r§,2s,P,m		P	4P,p			3P	
IV	Outer		p‖		s,H	3mII,II				

*Five-lobed adhesion pad.
†Single large denticulation.
‡Ramified spine; female with 6 rami (excluding tip), male with 7.
§Three roughened areas.
‖Several hairlike processes not tabulated.

DISCUSSION.—The species is tentatively placed in the genus *Lepeophtheirus* because the general characteristics most closely approximate those of *Lepeophtheirus* (e.g., fourth pedigerous segment free, not completely covered dorsally by median projection of cephalothorax; abdomen distinct, not fused with genital segment; first 3 thoracic legs biramous although endopodite of first leg reduced, fourth thoracic leg uniramous). These characteristics plus the lunule-like structure are also found in *Caligus*. The lunule-like structure, however, is not identical with that of *Caligus* and other lunule-bearing genera (see below).

The species differs from the majority of the species in *Lepeophtheirus* for the following reasons:

1. Part of the frontal region is modified to form a lunule-like process.

2. The fourth thoracic legs are 3-segmented, not 4-segmented, although *Lepeophtheirus* does include some species with 3-segmented fourth thoracic legs (e.g., *L. watanabei* Shiino, 1954d).

3. There are 4 terminal spines on the fourth thoracic legs instead of 3.

4. The endopodite of the first thoracic legs is larger than in most members of the genus. Many authors state that the first and fourth thoracic legs are uniramous in *Lepeophtheirus* (e.g., Wilson, 1905b, Yamaguti, 1963). The endopodite of the first leg of members of this genus is reduced or rudimentary but it is present (e.g., *L. dissimulatus* Wilson, 1905b; *L. gonistii* Yamaguti, 1936a) and the leg is biramous.

5. The postoral process is reduced, especially in the male.

The lunule-like structure of *L. fallolunulus* is formed of the upturned lateral anterior surface of the frontal region. Further, the structure is partially separated from the rest of the frontal area and has a strongly denticulated membrane instead of the frilled membrane found on the rest of the region. In *Caligus* and other lunule-bearing caligoids, the lunule is formed of part of the membrane found on the leading edge of the frontal region. In these, however, the membrane is either formed around a sinus in the frontal region or it itself forms a sinus. This structure can be simple (e.g., *C. enormis* Wilson, 1913) or the membrane can be well developed and the sinus remain open (e.g., *C. zei* Norman and Scott, 1906), or the membrane can be well developed, the sinus closed, and the lunule of a distinct cup shape (e.g., *C. coryphaenae* Steenstrup and Lütken, 1861). In all cases, however, the lunule is associated with some type of sinus and is directed ventrally. In *L. fallolunulus* there is no sinus, the structure is directed dorsally and not ventrally, and it is found only on the female.

In several characteristics, the species is similar to some members of the genus *Anuretes* and the genus *Pseudoanuretes*. *Anuretes parvulus* Wilson, 1913, resembles this species in the general shape of the fourth pedigerous segment and genital segment, antennule, and maxilliped, but it differs in the less distinct abdomen, the absence of the lunule-like structure, the reduction of the female postantennal process, the reduction of the sternal furca, and in the nature of most of the appendages. The 3 small, spinelike projections present on the inner surface of the second segment of the exopodite of the first thoracic leg in *L. fallolunulus* are also found in *Pseudoanuretes chaetodontis* Yamaguti, 1936a, while the ramified spine on the first segment of the exopodite of the second thoracic leg is similar to the condition of this spine in *Anuretes serratus* Shiino, 1954a.

The name "fallolunulus" is derived from the Latin terms "fallo" (deceive) and "lunula" (small moon) and refers to the nature of the lunule-like structure on the female.

Midias Wilson, 1911b

Diagnosis.—Cephalothorax ovoid, consisting of cephalon and first 4 thoracic segments. Frontal region distinct, with lunules. Free fourth pedigerous segment wider than long, tergal region heavily sclerotized (as is most of the dorsal body surface), with flaplike lateral extensions, segment without alae or separate plates in either sex. Genital segment with short, heavily sclerotized, spinelike fifth leg projections on posterior lateral surface. Abdomen of female 2-segmented, of male 1- or 2-segmented, basal segment of female with lateral lobes. Antennule 2-segmented; antenna 3-segmented, with clawlike terminal process, male with adhesion surfaces on first and second segments. Mandible rodlike, distal region curved inward, slightly flattened, with 12 denticulations along distal inner surface. Postantennal process consisting of spinelike projection and 3 nodules, each bearing several hairlike processes; postoral process spinelike, either bifid or simple, male with adhesion surface on distal region of process. Maxillule nodular, with setules; maxilla 2-segmented, tipped by 2 saber-shaped processes. Maxilliped 2-segmented, with clawlike terminal process; sternal furca well developed. Thoracic legs I–III biramous although endopodite of first leg reduced, fourth thoracic leg uniramous.

Remarks.—Two species have been described in this genus and are compared in the discussion section following the description of *M. lobodes*.

Wilson (1911b, p. 628) placed *M. lobodes* in the subfamily Euryphorinae (now recognized as a distinct family) because, "among general characters," of the large size, "the possession of rudimentary dorsal plates on the fourth" pedigerous segment, "a strongly inflated genital segment . . . an abdomen with lateral lobes on the basal joint and posterior lobes on the terminal joint," the possession of a 2-segmented endopodite on the first thoracic leg, and the presence of 3 segments in each of the rami of the third thoracic legs. Yamaguti (1963) accepts this placement and includes the genus in the Euryphoridae and in his subfamily Tuxophorinae, which includes both *Midias* and *Tuxophorus*, the latter of which has distinct alae on the fourth pedigerous segment.

The division between the Caligidae and the Euryphoridae is tenuous, both families sharing common characteristics. *Dentigryps*, a caligid genus, for example, possesses euryphorid-like fifth legs; *Pupulina*, a caligid, has euryphorid-like extensions of the genital segment. Additionally, one of the characteristics of the euryphorids is the presence of a biramous condition in the first 4 pairs of thoracic legs, yet *Gloiopotes*, a distinct euryphorid, has a distinctly uniramous fourth leg. The euryphorids are considered to be a transition group, between the caligids and the pandarids, and as such there are characteristics of the family that associate them with either or both the caligids and the pandarids.

Midias, *Dentigryps*, and a few other genera exhibit some characteristics which approach those of the Euryphoridae (see Lewis, 1964b, for a discussion of the association of *Dentigryps* with the Euryphoridae). *Midias* is characterized by having certain parts of the body heavily sclerotized. This condition is particularly noticeable on the tergal region and on some of the projections on the body and the appendages. The "dorsal plates," used as a euryphorid characteristic by Wilson, are not distinct plates but rather are thickenings of the tergum which are heavily sclerotized and do not project as do the plates of the alae-bearing groups. These thickenings are also found in other caligids (e.g., *Caligus productus* Dana, 1853). Of the other characteristics used by Wilson, the inflated genital segment is not unique (e.g., *Synestius*, a caligid), the lateral lobes of the first segment of the abdomen are also found in *Dartevellia*, and the posterior lobes on the abdomen are present in *Dentigryps curtus* Wilson, 1913, both of the last two being caligids. Further, the posterior lobes are not described for *Midias carangis* Rangnekar, 1956. The possession of a 2-segmented endopodite on the first thoracic leg is a qualifying characteristic although the endopodite is strongly reduced and no larger than that found in many caligids.

Midias is here placed in the Caligidae because of the absence of distinctly euryphorid characteristics, the presence of a uniramous, 4-segmented fourth thoracic leg, the presence of well-developed lunules, the presence of a spinelike projection as part of the postantennal process, and the presence of a reduced endopodite on the first thoracic leg. The author also accepts the fact that most of these characteristics are as open to criticism as are those Wilson used to include the genus in the Euryphoridae.

Midias lobodes Wilson

FIGURES 34–36

Midias lobodes Wilson, 1911b, p. 626, pl. 65; 1913, p. 225.—Causey, 1953b, p. 11.—Shiino, 1958, p. 98, figs. 1–3; 1963a, p. 343.—Yamaguti, 1963, p. 107, pl. 127, fig. 1.

DISTRIBUTION AND HOSTS.—4 host records:

locality	*hosts*	*references*
Gulf of Mexico	*Sphyraena barracuda*	Wilson, 1911b
Western Atlantic	*S. barracuda*	Wilson, 1913
Hawaii	*S. barracuda*	Shiino, 1963a
Indian Ocean	*Sphyraena* species	Shiino, 1958

MATERIAL.—One female and 1 male (USNM 112888) from the external surface of *Sphyraena barracuda* (Walbaum) captured 80 miles south of Oahu, Hawaii (USFWS). Two females and 2 males (retained by author) from the external surface of *S. barracuda* (Walbaum) captured in the Hawaiian region (USFWS).

MEASUREMENTS.—(In mm) 1 female and 3 males:

	female	*male*
Total length, excluding caudal setae	12.00	7.13, 6.90, 6.30
Length of cephalothorax, including frontal region	4.73	3.68, 3.68, 3.38
Width of cephalothorax	4.35	3.38, 3.38, 3.08
Length of genital segment, excluding fifth legs	3.29	1.55, 1.44, 1.33
Width of genital segment	3.33	1.81, 1.92, 1.85
Length of abdomen	3.29	1.70, 1.78, 1.67
Width of first segment of abdomen	3.11	
Length of fifth leg	0.27	0.48, 0.54, 0.56
Length of caudal rami	0.35	0.29, 0.31, 0.28

DESCRIPTION.—Female cephalothorax (fig. 34*a*) subovoid, consisting of cephalon and first 4 thoracic segments. Frontal region approximately one-fifteenth the length of cephalothorax, with pair of ovoid lunules and bearing fine membrane along anterior edge. Lateral cephalothoracic margin smoothly irregular, with fine membrane extending laterally and second membrane extending medially, from ventral edge. Posterior lateral surface of cephalothorax with small, pocket-like depression; posterior sinus (fig. 34*c*) narrow, outer and inner margins converging at opening, outer surface with fine membrane extending into sinus and second membrane extending laterally over division between lateral and median cephalothoracic regions. Median cephalothoracic region not extending past posterior end of lateral cephalothoracic regions, posterior margin irregular. Major dorsal cephalothoracic grooves forming irregular H; ocular region distinct in anterior third of body. Dorsal surface with scattered nodules, each bearing 1 or 2 hairlike processes.

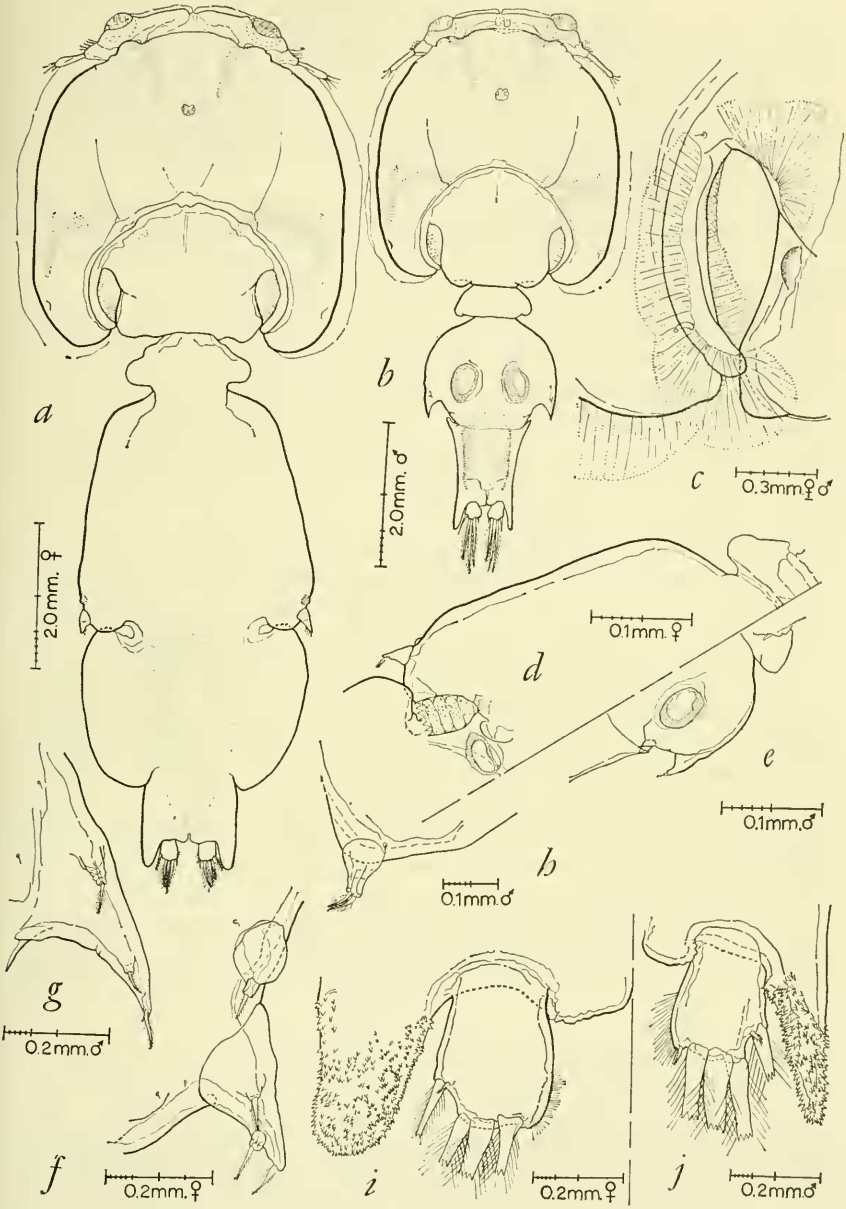


FIGURE 34.—*Midias lobodes* Wilson, 1911, dorsal view: *a*, female; *b*, male; *c*, posterior cephalothoracic sinus. Ventral view: *d*, female genital segment; *e*, male genital segment. Dorsal view: *f*, female right fifth leg; *g*, male, same. Ventral view: *h*, male right sixth leg; *i*, female caudal ramus and abdominal projection; *j*, male, same.

Female free fourth pedigerous segment distinct from cephalothorax, also from genital segment on ventral but not on dorsal surface. Segment short, expanded medially into small, flaplike projections over place of attachment of fourth thoracic legs. Genital segment (fig. 34*d*) broader posteriorly, tapered regularly from slightly narrower anterior end, lateral posterior surface slightly lobate. Fifth legs (fig. 34*f*) situated on posterolateral surface, consisting of minute, knoblike swelling, bearing single plumose setule, additional spikelike projection present immediately posterior to swelling, bearing 3 plumose setules, 2 on dorsal surface, third on distal inner surface.

Female abdomen indistinctly 2-segmented, incompletely separable from genital segment. First segment butterfly shaped; second segment subrectangular except for lobate outer distal surfaces, lobes denticulated. Caudal rami slightly narrower proximally than distally, distal half of inner margin plumose, distal surface with 3 plumose setae medially and 1 laterally in addition to 2 plumose setules, 1 adjacent to both outer and inner setae.

Male cephalothorax (fig. 34*b*) similar to that of female. Free fourth pedigerous segment with smaller lateral projections situated more posteriorly, but still over position of leg attachment. Genital segment (fig. 34*e*) distinct from both free fourth pedigerous segment and abdomen, lateral surfaces broadly convex, fifth legs (fig. 34*f*) spikelike, projecting from posterior lateral surfaces, spike bearing plumose setule from nodule on proximal dorsal surface, plumose setule from distal dorsal surface, and plumose setule from distal surface. Sixth legs (fig. 34*h*) present medial to fifth, consisting of node bearing 2 plumose setules distally. (The condition of the fifth and sixth legs of the male approaches that of the male of *Dentigryps*.) Abdomen appearing as 1 segment although indistinct evidence of second segment visible in posterior half. Abdomen broader anteriorly than posteriorly, lateral margins flatly concave, dorsal surface strongly concave. Outer distal surfaces lobate, lobes denticulated. Caudal rami as in female.

Female and male antennule (fig. 35*b*) 2-segmented, attached to ventral-lateral anterior surface of cephalothorax, just posterior to division between frontal region and remaining cephalothorax. First segment approximately 1⅓ times the length of second, distal half of anterior and anterior ventral surface bearing approximately 26 lightly plumose setae and setules. Second segment elongate, slightly longer in male than in female, with single naked setule from posterior medial surface, 11 from distal surface. Female antenna (fig. 35*c*) 3-segmented, situated slightly medial and posterior to antennule base. First segment short, knoblike, with small, heavily sclerotized subconical projection from posterior surface. Second segment short, subrectangular;

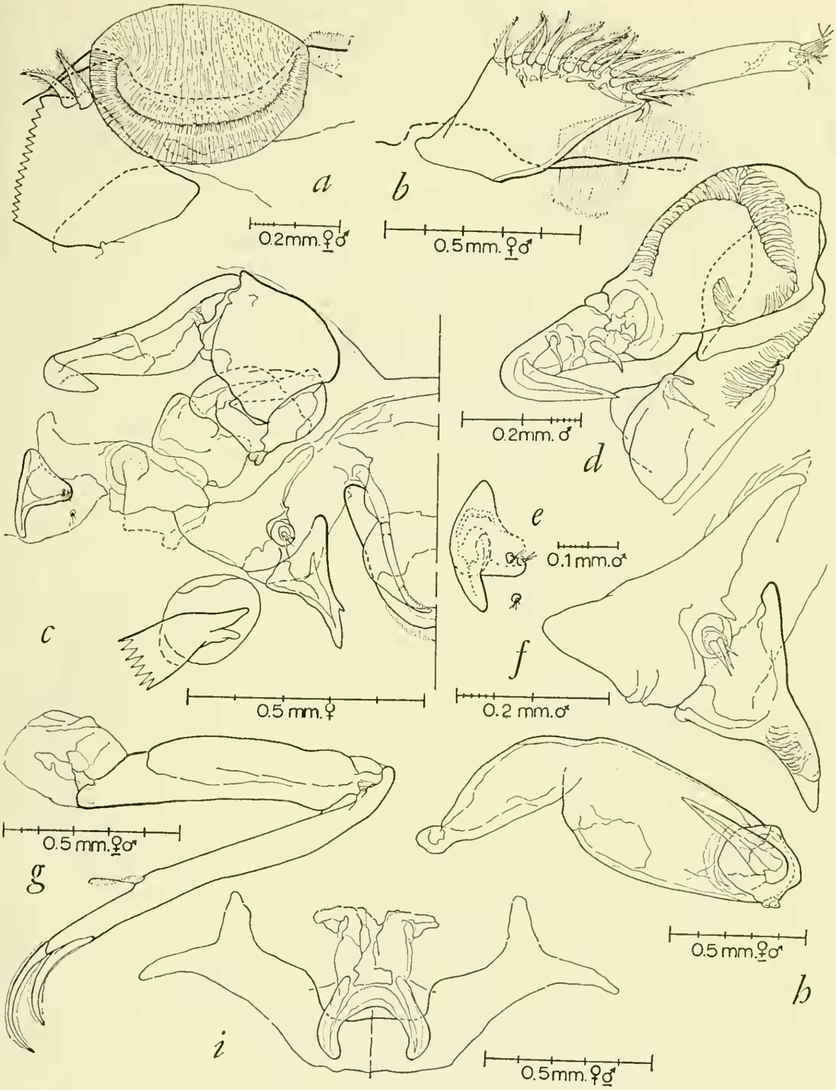


FIGURE 35.—*Midias lobodes* Wilson, 1911, ventral view: *a*, right side of frontal region showing lunule; *b*, left antennule; *c*, female oral region, right side showing antenna, postantennal process, mouth cone, mandible, maxillule, postoral process, and maxilla base; *d*, male right antenna; *e*, male right postantennal process; *f*, male right postoral process and maxillule; *g*, left maxilla; *h*, right maxilliped; *i*, sternal furca.

third segment fused with clawlike terminal process, bearing 2 setule-like accessory processes, 1 at indication of division between segment and terminal process, second from proximal inner surface. Male antenna (fig. 35*d*) basically similar to that of female although segments and processes relatively longer and first 2 segments bearing adhesion surfaces.

Female and male mandible (fig. 35*c*) 4-parted, distalmost part curved inward, with 12 denticulations on inner surface. Female post-antennal process (fig. 35*c*) consisting of short, spikelike projection, just lateral to antennal base, and 3 nodules, each with several hairlike processes; 2 nodules situated on base of spikelike projection, third just posterior to base. Male postantennal process (fig. 35*e*) similar to that of female although projection slightly thicker distally. Female postoral process (fig. 35*c*) spike shaped, with small spine projecting from distal half of inner surface. Male postoral process (fig. 35*f*) similar to that of female except with lappet-shaped accessory projection and adhesion surface. Female and male maxillule (fig. 35*c*) nodular, bearing 3 setules distally. Female and male maxilla (fig. 35*g*) 2-segmented, situated lateral and slightly posterior to postoral process. First segment approximately three-fourths the length of second, both elongate. Second segment with large, oval, membranous projection from distal half of inner surface, with 2 saber-shaped terminal processes. Innermost terminal process approximately 1½ times the length of outermost, both with very lightly frilled membranes along both inner and outer margins.

Female maxilliped (fig. 35*h*) 2-segmented, situated posterior and slightly medial to maxilla base. First segment strongly developed, with elongate proximal projection serving as articulation and muscle attachment surface. Second segment short, incompletely fused with clawlike terminal process, bearing small, setule-like accessory process from inner surface, at junction of segment and terminal process. Male maxilliped similar to that of female except first segment with transverse ridge on distal half of inner surface. Female and male sternal furca (fig. 35*i*) situated between and posterior to maxilliped bases, associated with heavily sclerotized transverse band on cephalothorax. Tines curving medially slightly toward distal ends, sinus U-shaped, lateral surface of tines thinner than medial and inner surfaces.

For nature of legs and armature, see figures 36*a–h* and table 13.

FIGURE 36.—*Midias lobodes* Wilson, 1911, right thoracic legs, anterior view: *a*, first; *b*, distal end of second segment of exopodite of first; *c*, second; *d*, third; *e*, exopodite of third (posterior view); *f*, first segment of exopodite of female third; *g*, male fourth; *h*, protopodite of female fourth.

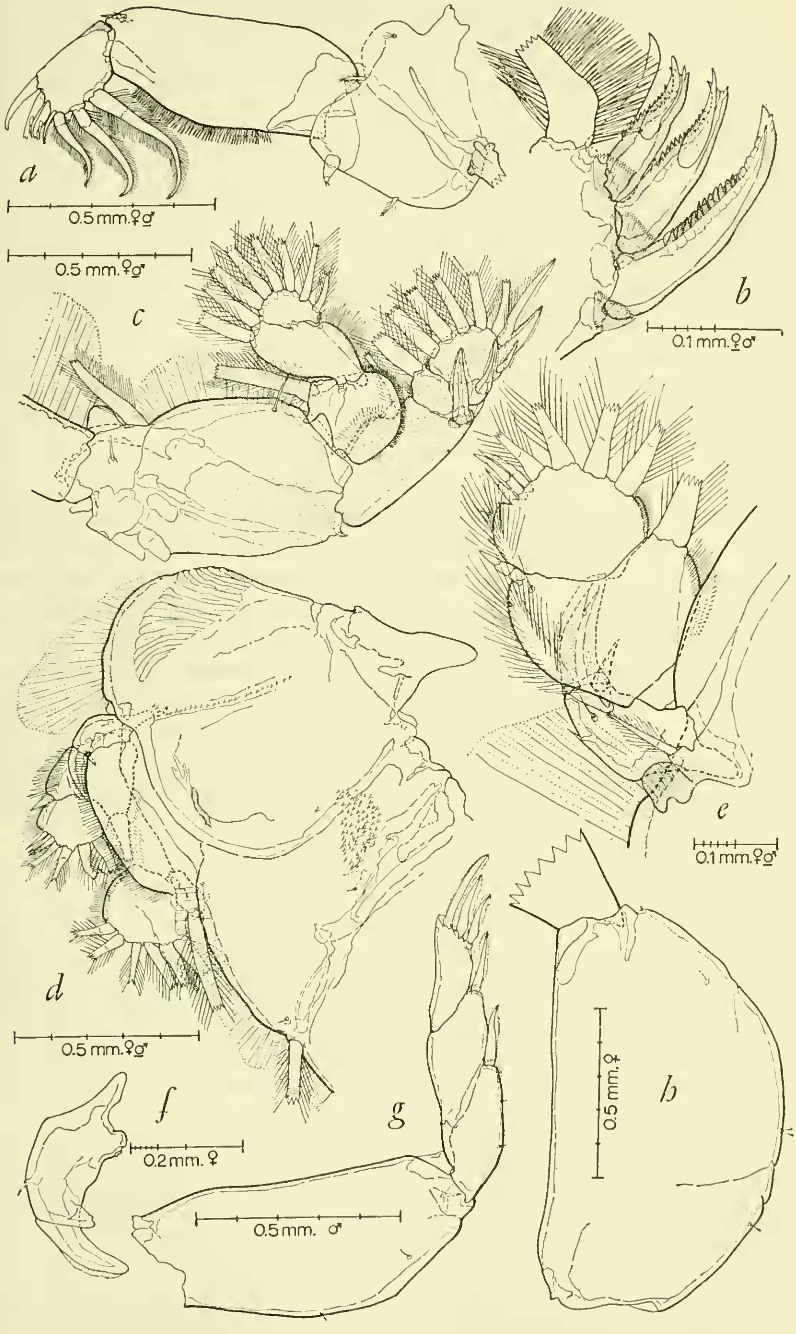

a
0.5 mm.♀♂
0.5 mm.♀♂
c
b
0.1 mm.♀♂
e
0.1 mm.♀♂
d
0.5 mm.♀♂
f
0.2 mm.♀
g
0.5 mm. ♂
h
0.5 mm.♀

TABLE 13.—*Armature of thoracic legs I–IV of the female and male of* Midias lobodes *Wilson, 1911b*

Leg	Surface	Interpodal Plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer		ss,p		fm,rh	3fm,3dH, H			ss	
	Inner		p		C	3P				
II	Outer	m		m,p	m,fm, dmH	dmH	2dmH,Q, P	c,C	c	c,3P
	Inner		s,P	m,s	c,P	c,P	c,4P	P	c,2P	c,3P
III	Outer	m	a,d,m,p		s,fmH	3s,c,p′	c,3p′,P	c	c,2P	
	Inner		d,3s,P,s, m,s			c,P	c,3P	P	c,4P	
IV	Outer		s,ss,s*(p†)		2s,fm,fmH	fm,fmH	3fm,3fmH			

*Female only.
†Male only.

DISCUSSION.—Several parts of Wilson's original description (1911b) need to be mentioned and characteristics that he did not describe should be discussed. These are characteristics noted not only on the Hawaiian material but also on the original type material. Wilson does not figure or describe an accessory process on the third segment of the antenna but a setule-like process is present in the female and 2 are present in the male (figs. 36*c, d*). The postantennal process is composed of 3 nodules, each bearing several hairlike processes, as well as a spinule-like projection. There is a great deal of variation in the spinelike projection forming the postoral process; basically, it is bifid in the female and simple in the male, but some of the female specimens in the collections of the U.S. National Museum have a simple process, while in others the process is bifid on one side and simple on the other (see discussion of *Gloiopotes huttoni* for similar case). Wilson indicates that the endopodite of the third thoracic leg is 3-segmented although in all of the specimens examined, including the type material, the endopodite is 2-segmented. There is a cuticular break in the second segment in all of the specimens (fig. 36*d*) but this break is incomplete and there is no indication of a 3-segmented condition, either in the cuticle or by the associated musculature.

Wilson deposited a series of cotypes (USNM 39613) in the type collection. One of these (a female, USNM 39613) has been selected as the lectotype, a second (male, USNM 112846) as the allolectotype, while the rest (USNM 112847) have been designated paralectotypes.

Rangnekar (1956) described the only other species in the genus, *M. carangis*. The feature which best distinguishes the two species is the presence of posterior lobes on the second segment of the abdomen of *M. lobodes* and their stated absence in *M. carangis*. A second characteristic is the described "sickle-shaped claw" on the first segment of the exopodite of the third thoracic leg in *M. carangis;* this claw is bifid in *M. lobodes.*

Caligus Müller, 1785

Diagnosis.—Cephalothorax consisting of cephalon and first 4 thoracic segments; frontal region distinct, with lunules. Free fourth pedigerous segment without alae, sometimes with small, lappet-like lateral projections of tergum extending over proximal surface of fourth thoracic leg. Genital segment of variable shape, infrequently with extensions of posterior lateral surface, without elongate, heavily sclerotized fifth leg projections. Abdomen 1–4 segmented, of variable length but not longer than combined lengths of cephalothorax, free fourth pedigerous segment and genital segment. Antennule 2-segmented; antenna 3-segmented, with clawlike terminal process, variously modified in male. Mandible rodlike, distal end curved inward, slightly flattened, distal inner surface with 12 denticulations. Postantennal process consisting of 3 nodules, each with several hairlike processes, usually with spinelike projection. Postoral process spinelike, simple or with small accessory spine. Maxillule nodular, with hairlike or setular projections; maxilla 2-segmented, terminated by 2 saber-shaped projections. Maxilliped 2-segmented, with clawlike terminal process and setule-like accessory process. Sternal furca present. Thoracic legs I–III biramous although endopodite of first reduced; fourth thoracic legs uniramous.

Caligus coryphaenae Steenstrup and Lütken

Figures 37–39

?*Caligus scutatus* Milne-Edwards, 1840, p. 453.

Caligus coryphaenae Steenstrup and Lütken, 1861, p. 360, pl. 4, fig. 7.—Richiardi, 1880, p. 148.—Valle, 1880, p. 58.—Carus, 1885, p. 358.—Bassett-Smith, 1899, p. 451.—Brian, 1899a, p. 4.—Wilson, 1905b, p. 556, 559 (key).—Brian, 1908, p. 2; 1912, p. 7.—Wilson, 1923, p. 5; 1937, p. 424.—Heegaard, 1949, p. 241, figs. 6–10.—Pearse, 1952a, p. 15.—Capart 1959, p. 81, fig. 14a–d.—Shiino, 1959b, p. 2, figs. 1–2; 1959d, p. 294, fig. 12.—Kurian, 1961, p. 68, figs. 16-24.—Nunes-Ruivo, 1962a, p. 70.—Pillai, 1962b, p. 513, figs. 1, 2.—Shiino, 1963a, p. 336, fig. 1.—Yamaguti, 1963, p. 51, pl. 59, fig. 3.

Caligus bengoensis Scott, 1894, p. 130, pl. 14, fig. 19.

Caligus aliuncus Wilson, 1905b, p. 576, pl. 9; 1935b, p. 330.—Bonnet, 1948, p. 7.—Causey, 1953b, p. 8.

Caligus elongatus Heegaard, 1943b, p. 11, figs. 21–31.

Caligus tesserifer Shiino, 1952, p. 89, fig. 5.

Not *Caligus coryphaenae.*—Brian, 1935, p. 51, figs. 19, 20.—Yamaguti, 1936a, p. 5, pl. 4, figs. 40–54.—Barnard, 1955, p. 246, figs. 8a–d.

Distribution and hosts.— 19 + host records:

locality	*hosts*	*reference*
Subtropical Atlantic	*Coryphaena*	Steenstrup and
	"Bonito"	Lütken, 1861
	C. hippurus	Brian, 1908
	Plankton	Scott, 1894
	Parathunus obesus	Nunes-Ruivo, 1962a
Gulf of Mexico	*Euthynnus alleteratus*	Wilson, 1935b
	Coryphaena hippurus	Pearse, 1952a
Eastern Pacific	*Sarda* species	Wilson, 1937
	Coryphaena hippurus	Heegaard, 1949
	Euthynnus lineatus	
	Katsuwonus pelamis	Shiino, 1959
Hawaii	*Euthynnus alleteratus*	Bonnet, 1948
	Coryphaena hippurus	Shiino, 1959d
Western Pacific	*Katsuwonus pelamis*	
	Coryphaena hippurus	Shiino, 1959b
Indian Ocean	Unknown	?Milne-Edwards, 1840
	Squalus acanthias	Wilson, 1923
	Neothunnus albacora	Shiino, 1959b
Mediterranean	*Coryphaena hippurus*	Richiardi, 1880

Material.—One female and 1 male (USNM 112889) from the external surface of *Katsuwonus pelamis* (Linnaeus) collected near Fanning Island (USFWS, LL cruise 9). One female (USNM 112890) from the external surface of *K. pelamis* (Linnaeus) collected at 20°35′N, 157°-45′W (USFWS, CHG cruise 30, station 30). One female and one male (USNM 112891) from the external surface of *K. pelamis* (Linnaeus) collected in the Hawaiian Island region (USFWS, HMS cruise 34). One female and 1 male (USNM 112892) from the external surface of *K. pelamis* (Linnaeus) collected at 20°4.5′N, 160°37.5′W (USFWS, HMS cruise 39, station 17). One immature male (USNM 112893) from the plankton, 0°00′N, 157°42′W (USFWS, HMS cruise 2, station 52). One female and one male (USNM 112894) from the external surface of *K. pelamis* (Linnaeus) collected 120 miles north of Oahu, Hawaii (USFWS). One female and 2 males (USNM 112895) from the external surface of *Euthynnus yaito* (Jordan and Evermann) collected at French Frigate Shoals (USFWS, HMS cruise 39, station 32). One male (USNM 112896) from the external surface of *Coryphaena hippurus* Linnaeus from unknown locality (in collections of U.S. Fish and Wildlife Service, Honolulu). Two females (USNM 112897) from the external surface of *Euthynnus yaito* (J. and E.) taken near Moku Manu Island, near Oahu, Hawaii (USFWS). One female and 1 male (USNM 112898) from the external surface of *Katsuwonus pelamis* (Linnaeus) collected at 2°S, 132°W (USFWS, JRM cruise 34, station 5). One male (USNM 112899) from the external surface of *Euthynnus yaito* (J. and E.) collected in unknown locality (USFWS, CHG cruise 52). Five females and 2 males (retained by author) from the external surface of *K. pelamis* (Linnaeus) captured by Robert Stevenson near Oahu, Hawaii.

Measurements.—(In mm) 13 females and 10 males:

	female		*male*	
	mean	*range*	*mean*	*range*
Total length, excluding caudal setae	6. 61	5. 85–7. 28	5. 52	4. 73–6. 00
Length of cephalothorax, including frontal region	3. 28	3. 03–3. 63	3. 52	3. 11–3. 74
Width of cephalothorax	2. 71	2. 44–3. 00	2. 78	2. 52–3. 03
Length of genital segment	1. 77	1. 30–2. 11	0. 99	0. 81–1. 11
Width of genital segment	1. 58	1. 33–1. 81	1. 25	1. 11–1. 33
Length of abdomen	1. 53	1. 06–1. 80	0. 82	0. 68–0. 94
Length of caudal rami	0. 25	0. 23–0. 30	0. 27	0. 23–0. 30
Length of egg strings (4 strings)	6. 15	2. 40–8. 78		

Description.—Female cephalothorax (fig. 37*a*) consisting of cephalon and first 4 thoracic segments, with several hairlike processes scattered over dorsal surface. Frontal region approximately one-fifteenth the length of cephalothorax, with narrow membrane along anterior margin; lunules large, projecting posteriorly, on ventral surface, past division between frontal region and remaining cephalothorax. Lateral cephalothoracic margins slightly irregular, with fine membrane, also with distinct socket-shaped depression posteriorly. Posterior sinus (fig. 37*c*) distinct, U-shaped, with finely serrated membrane along outer margin. Posterior median cephalothoracic region projecting slightly past lateral cephalothoracic regions, posterior margin flatly convex. Major dorsal cephalothoracic grooves forming irregular H, with posterior and anterior longitudinal grooves flaring outward, anterior extending to just posterior to ocular region. Ocular region distinct, pigment cups, containing lens element, contiguous on median longitudinal axis of body.

Female fourth pedigerous segment free, width approximately three times the length, dorsal surface raised slightly, appearing platelike. Genital segment (fig. 37*d*) distinct from fourth pedigerous segment, anterior end narrower than posterior, lateral margins wavy. Posterior lateral regions of genital segment lobate, projecting posteriorly slightly, bearing fifth legs on outer surface. Fifth leg (fig. 37*f*) consisting of 2 adjacent nodes, first bearing single plumose seta, second bearing 3 plumose setules. Median posterior surface of genital segment indistinctly and incompletely separable from abdomen. Abdomen considered 4-segmented by most workers although only 2 distinct divisions (3 segments) present, third division suggested by constriction. Anterior part of abdomen with constriction and may represent 2 segments although constriction superficial and developing eggs extend from genital segment through full length of first part of abdomen. Anterior part also with small, bean-shaped

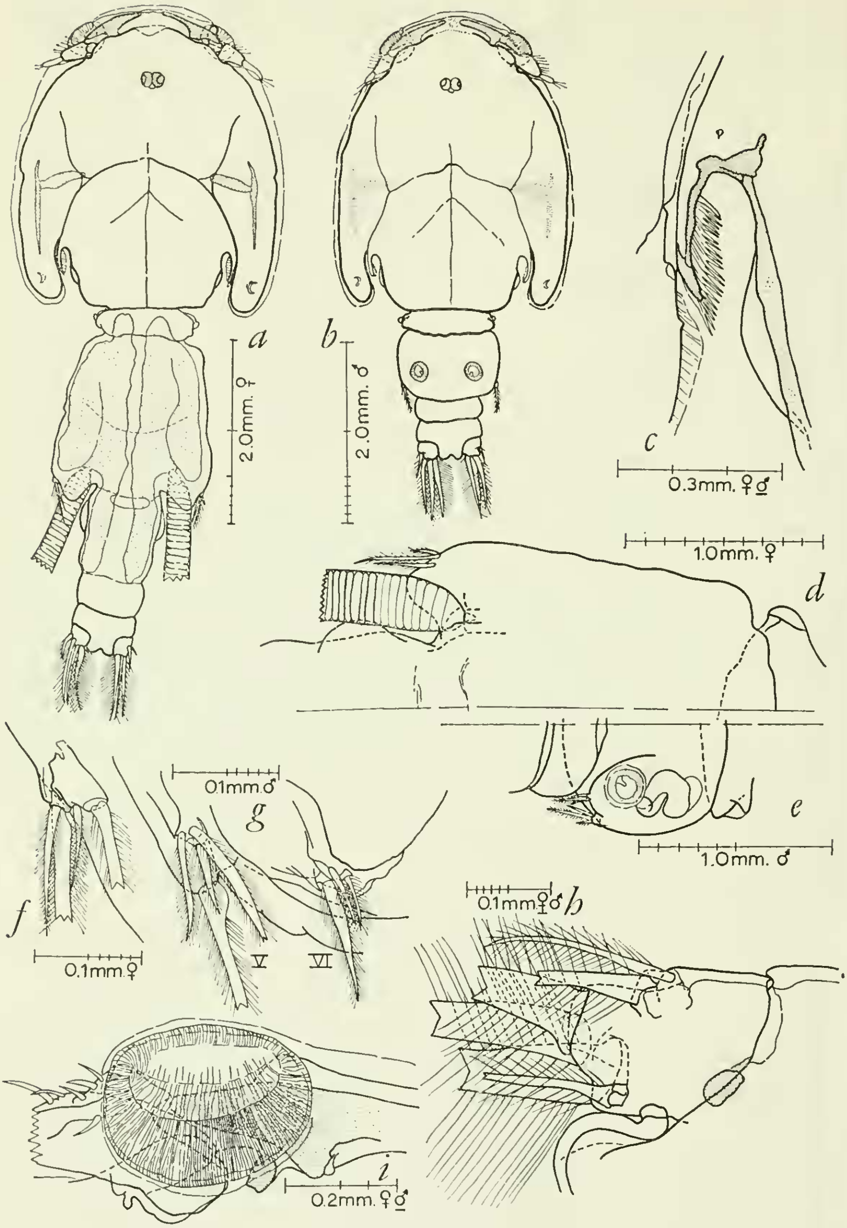


FIGURE 37.—*Caligus coryphaenae* Steenstrup and Lütken, 1861, dorsal view: *a*, female; *b*, male; *c*, posterior cephalothoracic sinus. Ventral view: *d*, female free fourth pedigerous segment, genital segment, and anterior end of abdomen; *e*, male, same; *f*, female fifth leg; *g*, male fifth (V) and sixth (VI) legs. Dorsal view: *h*, left caudal ramus; *i*, frontal region, right side showing lunule and antennule base.

process on anterior dorsal surface. Posteriormost segment with deep indentation in posterior half of lateral surface, indentations forming articulation and attachment surfaces for caudal rami. Caudal rami (fig. 37*h*) short, not extending past posterior end of last abdominal segment, bearing 3 large, plumose setae from medial posterior surface, 2 additional plumose setae from outer posterior surface; sixth plumose seta present on inner posterior surface.

Male cephalothorax and free fourth pedigerous segment (fig. 37*b*) similar to female. Genital segment (fig. 37*g*) suborbicular, lateral posterior surface indented, indentations bearing fifth legs. Fifth leg (fig. 37*g*) similar to that of female; sixth leg (fig. 37*g*) arising medial and slightly posterior to fifth, from broad, lappet-like pad, leg consisting of single plumose seta and 2 plumose setules. Abdomen distinct from genital segment, 2-segmented, first segment broader anteriorly than posteriorly, second segment similar to posteriormost segment of female. Caudal rami as in female.

Female and male antennule (fig. 38*a*) 2-segmented, attached to lateral-anterior ventral surface of cephalothorax, immediately posterior to division between frontal region and remaining cephalothorax. First segment more than twice the length of second, with approximately 17 plumose setae and setules in addition to 2 knobs along distal half of anterior ventral surface; second segment club shaped, with 1 plumose and 9 naked setae and setules in distal region. Female antenna (fig. 38*b*) 3-segmented, situated posterior and slightly medial to antennule base. First segment short, irregularly cup shaped, heavily sclerotized; second segment longer than first, length approximately 1⅕ times the width. Third segment fused with clawlike terminal process, bearing knoblike accessory process at indistinct break in sclerotization, in proximal third; second knoblike accessory processs at proximal end of segment. Male antenna (fig. 38*c*) 3-segmented, first 2 segments basically similar to those of female, third segment terminal process distinct from segment, with second claw at proximal end of process.

Female and male mandible (fig. 38*b*) 4-parted, fourth part flattened, with 12 denticulations along inner margin. Female and male postantennal process (fig. 38*b*) consisting of 3 nodules, each with several fine, hairlike processes. Female and male postoral process (fig. 38*b*) consisting of subtriangular, spinelike projection, bluntly pointed or rounded distally. Female and male maxillule (fig. 38*b*) nodular, bearing 3 setae, situated in depression of platelike area of heavy sclerotization between posterior margin of first segment of antenna and subtriangular postoral process. Ovoid area of heavy sclerotization present, extending posteriorly and medially between bases of maxillae, with ridgelike projection along axis. Female and male maxilla (fig. 38

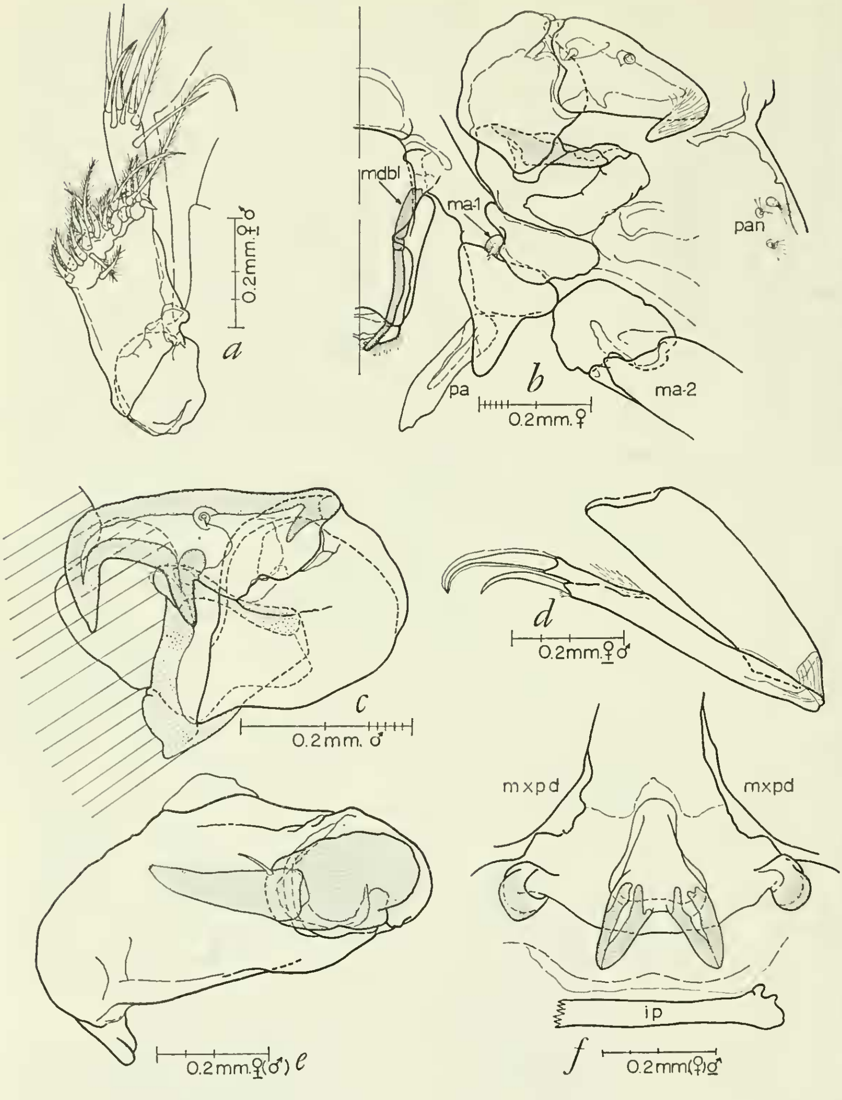


FIGURE 38.—*Caligus coryphaenae* Steenstrup and Lütken, 1861, ventral view: *a*, left antennule; *b*, female oral region, left side showing antenna, postantennal process (pan), mouth cone, mandible (mdbl), maxillule (ma-1), postoral process, postoral adhesion pad (pa), and maxilla base (ma-2); *c*, male right antenna; *d*, left maxilla; *e*, right maxilliped; *f*, sternal furca, maxilliped bases (mxpd), and interpodal plate of first thoracic leg (ip).

d) 2-segmented, situated just lateral and posterior to postoral process. First segment slightly shorter than second, excluding terminal processes, although wider; second segment elongate, tapered proximally and distally, bearing membrane from middle of inner margin and 2 saber-shaped terminal processes, each with membrane along margins.

Female maxilliped (fig. 38*e*) 2-segmented, situated posterior and medial to maxilla base. First segment approximately 2½ times the length of second, strongly developed, width slightly less than half the length. Second segment distinct from clawlike terminal process, bearing single, setule-like accessory process from posterior-inner distal surface. Male maxilliped similar to that of female although first segment with small, ledge-shaped projection on proximal inner surface. Female and male sternal furca (fig. 38*f*) situated between posterior ends of maxilliped bases. Furcal tines diverging widely, heavily sclerotized. Pair of lappet-shaped projections present, lateral to base of furca.

For nature of legs and armament, see figure 39 and table 14.

TABLE 14.—*Armature of thoracic legs I–IV of the female and male of* Caligus coryphaenae *Stecnstrup and Lütken, 1861*

Leg	Surface	Inter-podal Plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer		ss,s,p		rh	3dmH,p′				
	Inner		p		c	3P				
II	Outer	m		m,p	m,m,mH	mH	2II,Q	C	C	C,3P
	Inner		p′,P	m,p	c,P	c,P	c,5P	P	c,2P	c,3P
III	Outer	m	d,m,p		mII	p′*,c,p′	c,3p′,p	c	c,2P	
	Inner		d,P,s,m,s			c,P	3P	P	4P	
IV	Outer		p		fm,dII†	fm,dH†	fm,dH,fm, dII,fm,dII†			

*Element in middle of segment.
†Female has denticulated membrane, not separate denticulatious as in male.

DISCUSSION.—Steenstrup and Lütken (1861, p. 362) state that "Our *C. coryphaenae* also seems closely related to *C. scutatus* M. Edw. (hist. d. Crust. t. III P. 453 no. 7), but as this is from the Indian Ocean it does not seem probable to us that this is the same species." The present distribution and hosts of *Caligus coryphaenae* suggest that Steenstrup and Lütken erred in using the different location as a

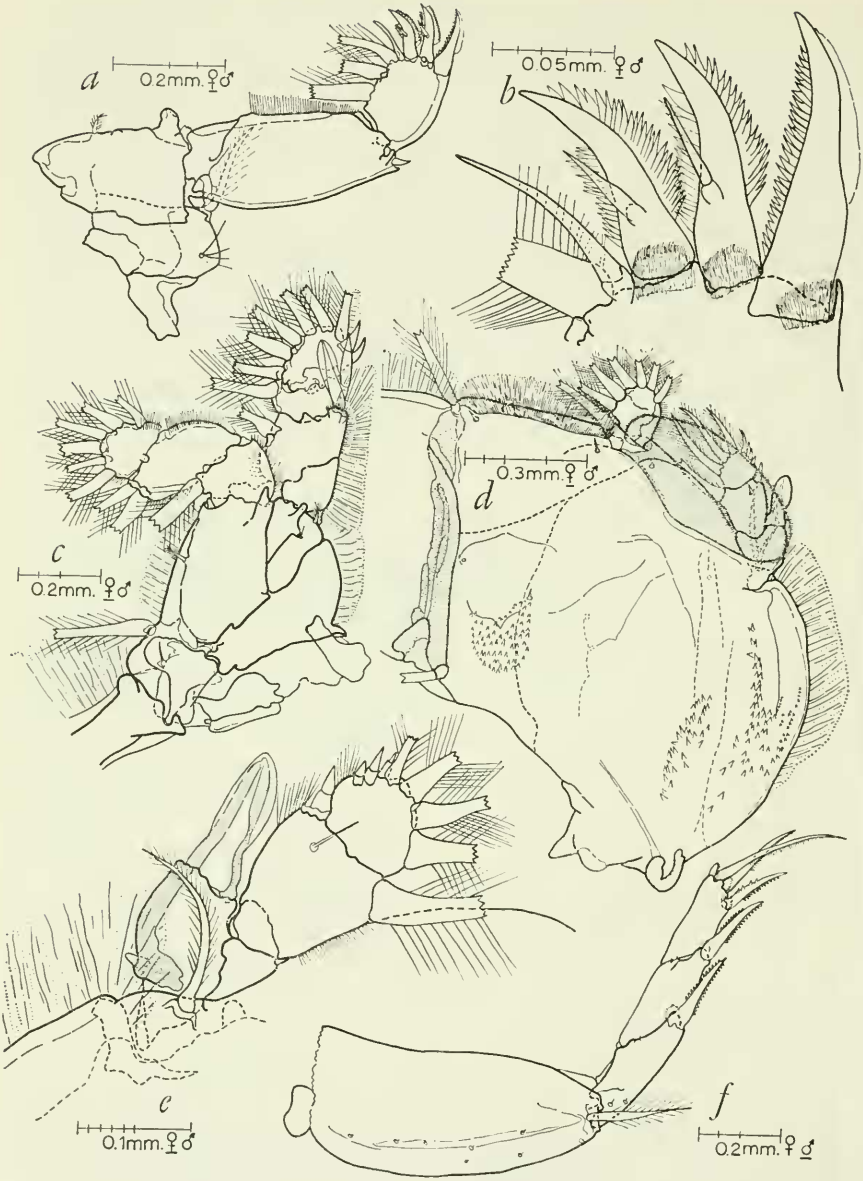


FIGURE 39.—*Caligus coryphaenae* Steenstrup and Lütken, 1861, right thoracic legs, anterior view: *a*, first; *b*, distal region of second segment of exopodite of first; *c*, second; *d*, third; *e*, exopodite of third (posterior view); *f*, fourth.

primary reason for separating the two species. Milne-Edwards (1840), however, does not provide a figure of *C. scutatus* and does not list the host from which the female specimen(s?) (male unknown) was collected. Further, *C. scutatus* is not given in a list of Milne-Edwards' species contained in the Paris Museum where most of his specimens were deposited (list sent to Dr. R. Parker, Fisheries Research Board of Canada, Nanaimo, British Columbia). Because of the lack of a definitive description and specimens of *C. scutatus*, it is felt best to use the name only as a questionable entry in the synonymy of C. *coryphaenae.*

The deletion of Brian, 1935, and Barnard, 1955, from the synonymy is based on Pillai's 1962b discussion of the synonymy of *C. coryphaenae.* Shiino, 1959b, also lists *Caranx pelagica, Seriola dorsalis, Rachycentron canadus*, and *Caranx hippos* as reported hosts.

Caligus quadratus Shiino

Figures 40–42

Caligus productus.—Rathbun, 1884, p. 487.—Wilson, 1905b, p. 597, pl. 14, figs. 162–170.

Caligus coryphaenae.—Yamaguti, 1936a, p. 5, pl. 4, figs. 162–170.

Caligus quadratus Shiino, 1954c, p. 26, fig. 1; 1959b, p. 8, figs. 3–5; 1960a, p. 472.—Yamaguti, 1963, p. 59, pl. 75, fig. 4.

Distribution and hosts.—8 host records:

locality	*host*	*reference*
Japan	*Neothynnus macropterus*	
	Histiophorus orientalis	
	Coryphaena hippurus	
	Neothunnus albacora	
	Rhinobatus schlegelii	Shiino, 1954c, 1959b, 1960a
"Pacific"	*Coryphaena hippurus*	Yamaguti, 1936a
Atlantic	*Coryphaena hippurus*	Wilson, 1905b
Western North Atlantic	*Coryphaena* species	Rathbun, 1884

Material.—Five females and 2 males (USNM 112900) from the gill cavity of *Coryphaena hippurus* Linnaeus captured at 15°N, 155°30′W (USFWS, HMS cruise 36, stations 26–27). Two females (1 immature) (USNM 112901) from the gill cavity of *C. hippurus* Linnaeus captured 120 miles south of Oahu, Hawaii (USFWS). Two females (1 immature) (USNM 112902) from the gill cavity of *C. hippurus* Linnaeus captured 130 miles south of Niihau, Hawaii (USFWS, HMS cruise 39). Three females and 1 male (retained by author) from the buccal cavity, external surface and gill cavity of *C. hippurus* Linnaeus captured near Oahu, Hawaii.

MEASUREMENTS.—(In mm) 11 females and 3 males:

	female		*male*
	mean	*range*	
Total length, excluding caudal setae	5. 02	3. 90–6. 15	3. 50, 3. 25, 2. 85
Length of cephalothorax, including frontal region	1. 79	1. 28–2. 08	1. 93, 1. 95, 1. 53
Width of cephalothorax	1. 65	1. 30–1. 88	1. 65, 1. 58, 1. 33
Length of genital segment	1. 55	1. 33–1. 80	0. 73, 0. 60, 0. 55
Width of genital segment	1. 24	1. 08–1. 43	0. 58, 0. 55, 0. 43
Length of abdomen	1. 64	1. 20–2. 18	0. 73, 0. 60, 0. 53
Length of caudal rami	0. 15	0. 10–0. 18	0. 18, 0. 19, 0. 13
Length of egg strings (4 strings)	2. 33	1. 25–3. 05	

DESCRIPTION.—Female cephalothorax (fig. 40*a*) ovoid, consisting of cephalon and first 4 thoracic segments. Frontal region slightly more than one-tenth the length of cephalothorax, with membrane along most of anterior margin. Lunules extending posteriorly, on ventral surface, past junction of frontal region and rest of cephalothorax. Lateral margin of cephalothorax slightly irregular, with numerous small indentations, bearing narrow membrane extending laterally and second, frilled membrane extending medially, on ventral surface. Posterior lateral cephalothoracic surface with small, pocket-like depression on dorsal surface. Posterior sinus (fig. 40*c*) irregularly V-shaped, with fine membrane along outer surface. Posterior margin of median cephalothoracic area irregularly convex, area extending posteriorly slightly past lateral areas, with 3 pairs of minute, hairlike processes on median-posterior dorsal surface. Major dorsal cephalothoracic grooves forming irregular H; dorsal surface with scattered minute, hairlike processes, in addition to those on posterior median surface. Ocular region distinct, in anterior third of cephalothorax, pigmented cups contiguous on median longitudinal axis of body.

Female free fourth pedigerous segment broadest medially, angled toward anterior and posterior ends. Segment distinct from cephalothorax, distinctly separable from genital segment ventrally, indistinctly separable dorsally. Genital segment (fig. 40*d*) variable in shape, subovoid to rectangular, anterior lateral and lateral posterior surfaces frequently slightly lobate. Fifth leg (fig. 40*f*) situated on lateral ventral surface in posterior fourth of segment, consisting of 2 nodules, outermost with single lightly plumose setule, innermost with 2 lightly plumose setules.

Abdomen elongate, consisting of 1 or more segments, distinct from genital segment. Anterior end of abdomen narrower ventrally than dorsally. Lateral surfaces irregular, with several distinct constrictions in some specimens, constrictions absent in others. Abdomen narrower posteriorly than anteriorly, posterior region (ap-

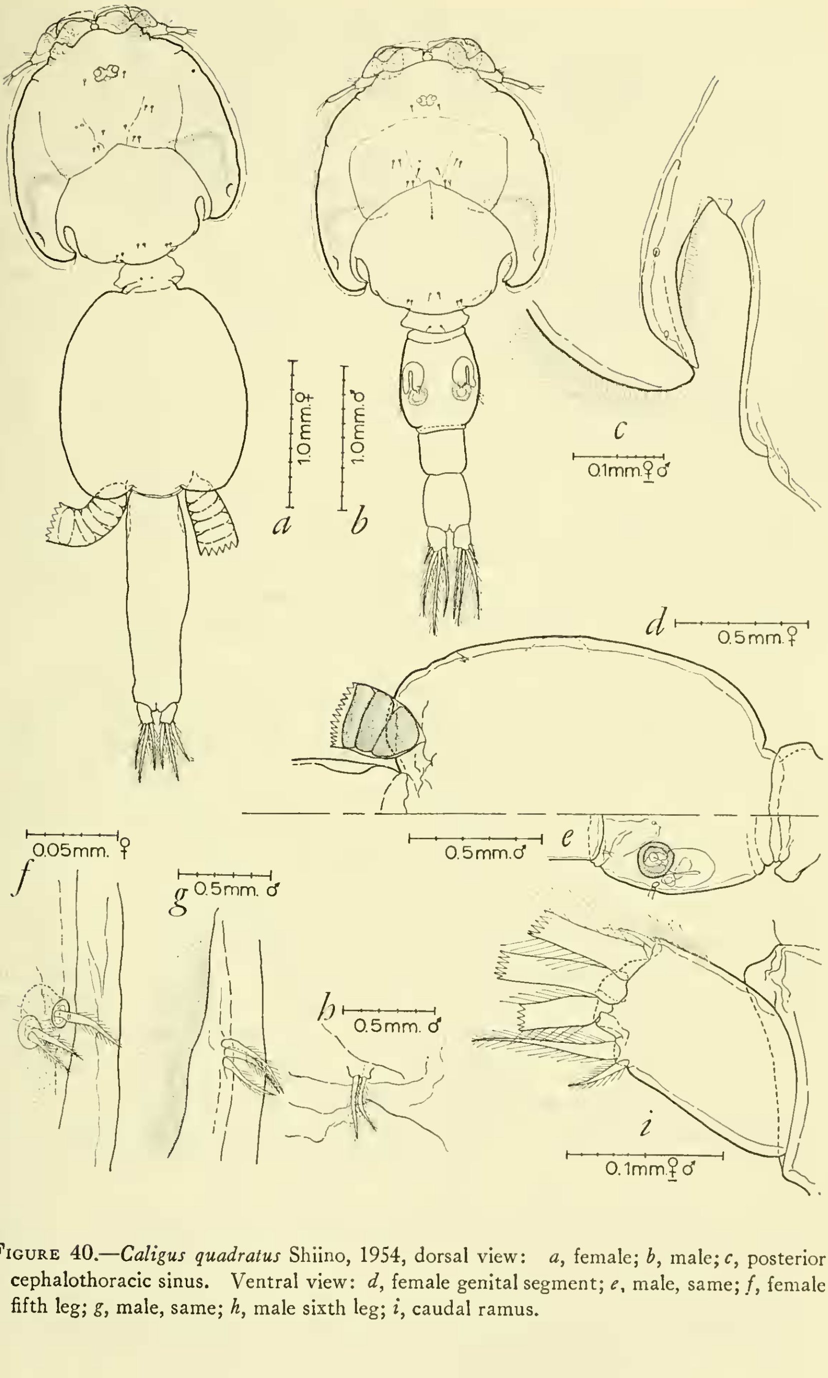


Figure 40.—*Caligus quadratus* Shiino, 1954, dorsal view: *a*, female; *b*, male; *c*, posterior cephalothoracic sinus. Ventral view: *d*, female genital segment; *e*, male, same; *f*, female fifth leg; *g*, male, same; *h*, male sixth leg; *i*, caudal ramus.

proximately one-seventh the total length) with almost parallel sides, region with indistinct evidence of division from rest of abdomen. Posterior end of abdomen with concave lateral surfaces, irregularly U-shaped median region, at anal opening. Caudal rami (fig. 40*i*) subrectangular, inner margin plumose distally, distal surface with 3 plumose setae medially, fourth plumose seta laterally; 2 plumose setules also present, one on either side of setae.

Cephalothorax of male (fig. 40*b*) similar to that of female. Free fourth pedigerous segment of similar shape although division between segment and genital segment distinct, segment bearing ridgelike area of heavy sclerotization posteriorly, extending from posterior end of fourth leg attachment surface. Genital segment (fig. 40*e*) barrel shaped, constricted slightly anteriorly. Fifth legs (fig. 40*g*) situated in posterior half of ventral lateral surface, consisting of 3 lightly plumose setules. Sixth legs (fig. 40*h*) situated on posterior-lateral ventral surface, consisting of pair of lightly plumose setules arising from nodule. Abdomen 2-segmented, distinct from genital segment. Second segment slightly less than 1¼ times the length of first, first subrectangular; second segment narrower anteriorly than posteriorly, lateral margins flatly convex, posterior surface as in female. Caudal rami as in female.

Female antennules (fig. 41*b*) 2-segmented, attached to lobate projection of lateral anterior-ventral surface of cephalothorax. First segment slightly less than 1½ times the length of second, broad proximally, tapered to narrow distal surface; distal half of anterior and anterior ventral surface bearing approximately 26 lightly plumose setules and setae. Second segment rod shaped, distal region with approximately 12 naked setules. Male antennule similar to that of female except second segment (fig. 41*c*) longer. Female antenna (fig. 41*d*) 3-segmented, situated posterior and slightly medial to antennule base. First segment stubby, irregular, base subtriangular, bearing small, heavily sclerotized, subconical projection from outer posterior surface. Second segment well developed, broader proximally than distally. Third segment indistinctly separable from clawlike terminal process, bearing setule-like accessory process from distal lateral surface and small, lappet-like process from proximal posterior surface. Male antenna (fig. 41*e*) 3-segmented, first segment short, subovate, concave distally. Second segment club shaped, narrow end distalmost, with small adhesion surface on proximal anterior surface and second, ridge-shaped adhesion surface on distal half of inner surface. Third segment short, indistinctly separable from trifid terminal process, bearing setule-like accessory process from anterior distal surface. Tines of trifid terminal process short, situated at distal end of process.

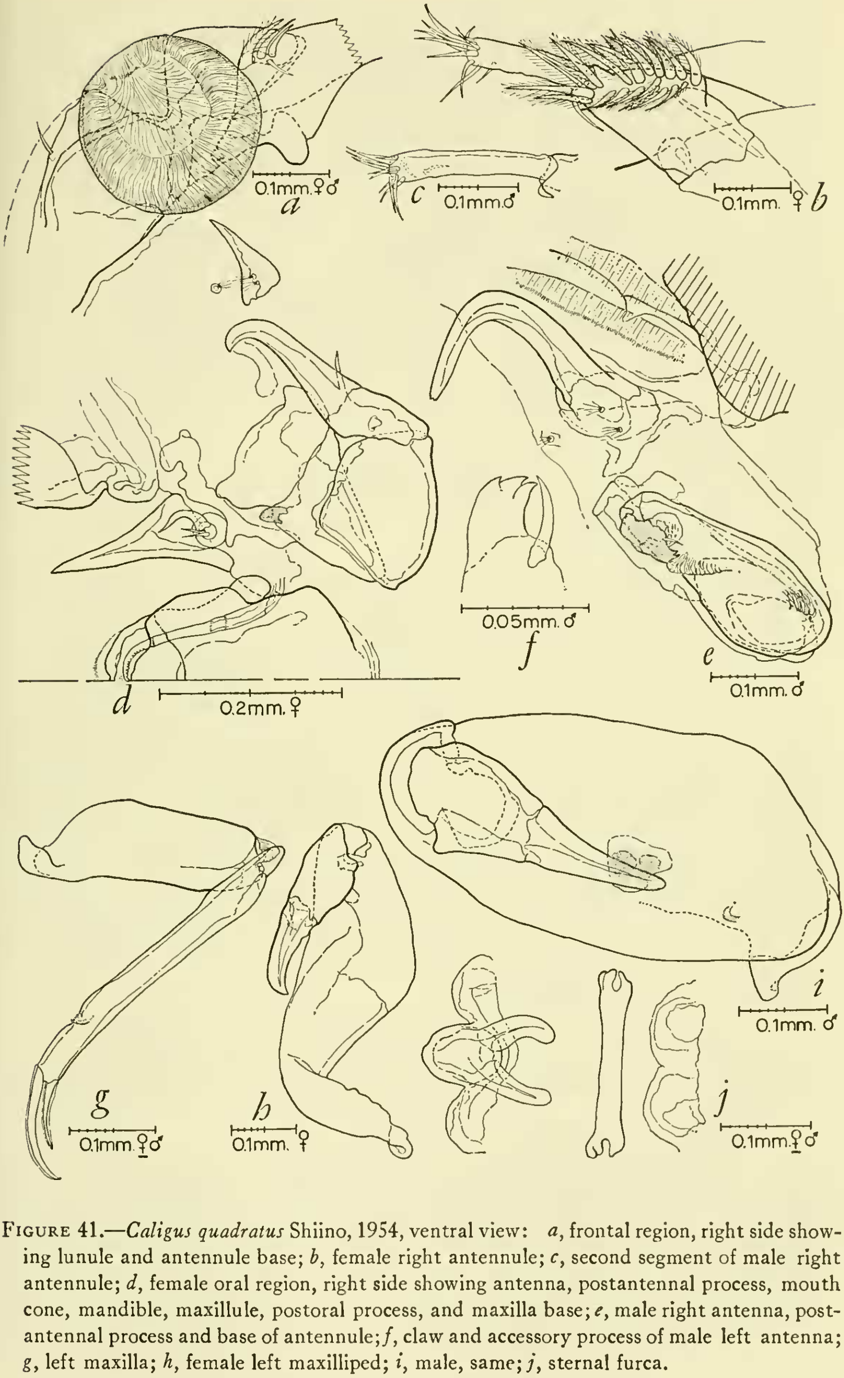


FIGURE 41.—*Caligus quadratus* Shiino, 1954, ventral view: *a*, frontal region, right side showing lunule and antennule base; *b*, female right antennule; *c*, second segment of male right antennule; *d*, female oral region, right side showing antenna, postantennal process, mouth cone, mandible, maxillule, postoral process, and maxilla base; *e*, male right antenna, postantennal process and base of antennule; *f*, claw and accessory process of male left antenna; *g*, left maxilla; *h*, female left maxilliped; *i*, male, same; *j*, sternal furca.

Female and male mandible (fig. 41*d*) 4-parted, distalmost part curved medially, with 12 denticulations along inner surface. Female postantennal process (fig. 41*d*) situated lateral to antennal base, consisting of short, spinelike projection bearing pair of nodules on proximal surface, third nodule present slightly posterior to base of projection, all 3 nodules with several hairlike processes. Male postantennal process (fig. 41*e*) also consisting of spinelike projection and 3 nodules although projection much longer and strongly curved. Female and male postoral process (fig. 41*d*) spinelike, elongate. Female and male maxillule (fig. 41*d*) nodular, with 3 setules distally. Female and male maxilla (fig. 41*g*) 2-segmented, situated lateral and slightly posterior to postoral process. First segment more than four-fifths the length of second; second segment elogate, with small, horseshoe-shaped membrane from distal medial surface and 2 saber-shaped terminal processes. Innermost terminal process slightly less than 1½ times the length of outermost, bearing fine, filmy membrane along inner margin; outermost with very finely frilled membrane along both outer and inner margins.

Female maxilliped (fig. 41*h*) 2-segmented, situated posterior and slightly medial to maxilla base. First segment well developed, with long, strongly curved proximal articulation and muscle attachment projection. Second segment distinct from clawlike terminal process, bearing setule-like accessory process on distal inner surface. Male maxilliped (fig. 41*i*) more strongly developed, proximal projection of first segment shorter, inner medial surface of segment with small nodes proximally, larger node distally (node spinelike on 1 maxilliped of 1 of the 3 specimens); second segment and processes as in female. Female and male sternal furca (fig. 41*j*) situated between and slightly posterior to maxilliped bases. Furca with slightly curved or straight tines, arising from butterfly-shaped area of heavy sclerotization. Second butterfly-shaped area present between interpodal plates of first and second thoracic legs.

For nature of legs and armature, see figure 42 and table 15.

Discussion.—The Hawaiian specimens here described as *C. quadratus* Shiino differ from Shiino's 1954c and 1959b description as follows:

1. The terminal process of the male antenna differs from that shown by Shiino although he does not include a lateral view of this structure in his figures. The terminal process of the Hawaiian specimens more closely resembles that of *C. kuroshio* Shiino, 1959c, although the characteristic denticulation of the outer margin of the second segment of the endopodite of the second thoracic leg of *C. quadratus* and the Hawaiian specimens is not indicated. The

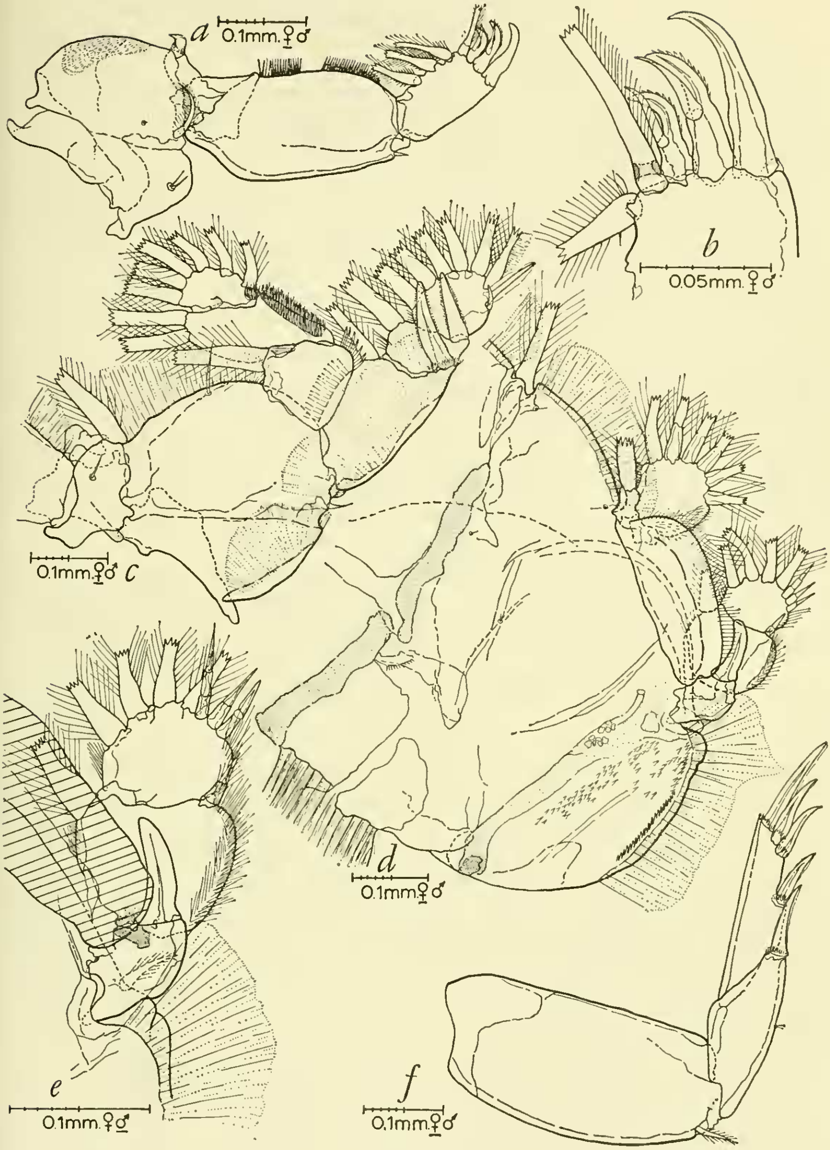


Figure 42.—*Caligus quadratus* Shiino, 1954, right thoracic legs, anterior view: *a*, first; *b*, distal end of second segment of exopodite of first; *c*, second; *d*, third; *e*, exopodite of third; *f*, fourth.

TABLE 15.—*Armature of thoracic legs I–IV of the female and male of* Caligus quadratus *Shiino, 1954c*

Leg	Surface	Inter-podal Plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer		ss,p		rh	H,2dH,P				
	Inner		d,p		c,c	3P				
II	Outer	m		m,p	m,fm,fmH	fmH	h,mH,Q	D	D	D,3P
	Inner		s,P	m,s	c,P	c,P	c,5P	P	c,2P	c,3P
III	Outer	m	d,m,p		H	c,p′	c,3p′,P	c	c,2P	
	Inner		2s,P,s,m,s			c,P	c,3P	P	c,4P	
IV	Outer		s,p		s,fm,fmH	4fm,4mH				

Hawaiian specimens also differ from *C. kuroshio* in the nature of other appendages and the body.

2. Shiino does not figure or describe a break in the plumosities on the inner margin of the first segment of the exopodite of the first thoracic leg in *C. quadratus*. This break, although slight, is distinct in the Hawaiian specimens.

Caligus quadratus and the following 2 species of *Caligus* are difficult to separate. A discussion of the characteristics most readily usable is given following the description of the third species.

Caligus productus Dana

FIGURES 43–45

Caligus productus Dana, 1853, p. 1354, pl. 94, fig. 4.—Steenstrup and Lütken, 1861, p. 357, pl. 3, fig. 6.—Krøyer, 1863, p. 138. pl. 3, fig. 4a–i.—Brian, 1898, p. 10.—Bassett-Smith, 1899, p. 452.—Brian, 1906, p. 42.—Fowler, 1912, p. 481.—Wilson, 1913, p. 208.—Brian, 1935, P. 53.—Pearse, 1952a, p. 15.—Causey, 1953a, p. 6; 1953b, p. 10; 1955, p. 5.—Shiino, 1959b, p. 14, figs. 6–8.—Causey, 1960, p. 329.—Shiino, 1960a, p. 471.—Hewitt 1963, p. 65.—Shiino, 1963a, p. 335.—Yamuguti, 1963, p. 58, pl. 73, fig. 3.—Kirtisinghe, 1964, p. 53, figs. 25–26.

Caligus monacanthi Krøyer, 1863, p. 59, pl. 3, fig. 2a-e.—Wilson 1905b, p. 607; 1937, p. 424, figs. 6–19.

Caligus lobatus Wilson, 1935a, p. 1, pl. 1, figs. 1–10.

Caligus katuwo Yamaguti, 1936a, p. 6, pl. 4, fig. 55; pl. 5, figs. 56–68.—Shiino, 1954f, 1 fig.—Nunes-Ruivo, 1956, p. 11, pl. 1, fig. b; pl. 2, fig. b.

DISTRIBUTION AND HOSTS.—37+host records:

locality	*hosts*	*references*
Subtropical Atlantic	*Thymnus pelamys* [sic]	Dana, 1853
	Thynnus	Steenstrup and Lütken, 1861
	Coryphaena	
	Monacanthus species	Kröyer, 1863
	Bonito	Fowler, 1912
	Naucrates ductor	Wilson, 1935a
	Neothunnus albacora	Nunes-Ruivo, 1956

locality	*hosts*	*references*
Gulf of Mexico	*Scomberomorus cavalla*	
	Sarda sarda	
	Elops saurus	
	Coryphaena hippurus	Pearse, 1952a
	Scomberomorus maculatus	Causey, 1953b
	Pogonias cromis	Causey, 1955
Eastern Pacific	Bonito	Wilson, 1937
	Auxis thazard	
	Coryphaena hippurus	
	Neothunnus albacora	Shiino, 1959b
	Seriola dorsalis	
	Paralabrax clathratus	
	P. maculatofasciatus	
	Verrunculus polylepos	
	Mackerel	
	Katsuwonus vagans	
	Sphyraena argentea	
	Scomberomorrus sierra	
	Coryphaena species	
	Seabass	
	Calamus brachysomus	
	Lutianus species	
	Centropomus species	Causey, 1960
Japan	*Katsuwonus pelamis*	
	Coryphaena hippurus	Shiino, 1959b
"Pacific"	*Euthynnus pelamys*	Yamaguti, 1936a
Indian Ocean	*Coryphaena hippurus*	
	Katsuwonnus pelamis	
	Euthynnus affinis	Kirtisinghe, 1964
Mediterranean	*Chrysophrys aurata*	Brian, 1898

Material.—Twenty-one females and 15 males (USNM 112904) from the extenal surface of *Katsuwonus pelamis* (Linnaeus) captured near Oahu, Hawaii by Robert Stevenson. One male (USNM 112905) from the external surface of *Neothunnus macropterus* (Schlegel) captured by D. W. Strasburg off Kona, Hawaii. One immature female (USNM 112906) from the buccal cavity of *Auxis thazard* (Lacépède) collected south of Nawiliwili, Kauai, Hawaii (USFWS, HMS cruise 39, station 37). One female and 1 male (USNM 112907) from the gill cavity of *Euthynnus yaito* (Jordan and Evermann) from an unknown locality (USFWS). One male (USNM 112908) from the external surface of *Katsuwonus pelamis* (Linnaeus) collected in the Hawaiian region (USFWS, HMS cruise 34). One immature female and 1 male (USNM 112909) from the external surface of 2 specimens of *K. pelamis* (Linnaeus) captured at 20°41.5′N, 160°37.5′W (USFWS, HMS cruise 39, station 17). One female and 1 male (USNM 112910) from the gill cavity of *K. pelamis* (Linnaeus) captured at an unknown locality (USFWS). Three females (retained by author) from the gill cavity of 3 specimens of *K. pelamis* (Linnaeus) captured southeast of Kauai, Hawaii (USFWS, HMS cruise 39). Three females and 1 male (retained by author) from the gill cavity of *K. pelamis* (Linnaeus) captured at 20°41.5′N, 160°37.5′W (USFWS, HMS cruise 39, station 17). Four females and 2 males (retained by author) from the gill cavity of *K. pelamis* (Linnaeus) captured 120 miles north of Oahu, Hawaii (USFWS). One female and 1 male (retained by auther) from the external surface and gill cavity of *K. pelamis* (Linnaeus) captured at 2°S, 132°W (USFWS, JRM cruise 34, station 5).

Measurements.—(In mm) 32 females and 22 males:

	female		male	
	mean	*range*	*mean*	*range*
Total length, excluding caudal setae	4. 80	4. 10–5. 45	4. 58	4. 05–5. 15
Length of cephalothorax including frontal region	2. 16	1. 83–2. 33	2. 39	2. 10–2. 78
Width of cephalothorax	1. 92	1. 50–2. 10	2. 04	1. 88–2. 28
Length of genital segment	1. 58	1. 05–1. 93	1. 07	0. 90–1. 20
Width of genital segment	1. 09	0. 80–1. 28	0. 75	0. 65–0. 83
Length of abdomen	1. 14	0. 96–1. 39	0. 87	0. 47–1. 00
Length of caudal rami	0. 24	0. 19–0. 27	0. 26	0. 22–0. 29
Length of egg strings (17 strings)	2. 86	1. 50–4. 15		

Description.—Female cephalothorax (fig. 43*a*) ovoid, consisting of cephalon and first 4 thoracic segments. Frontal region approximately one-twelfth the length of cephalothorax, with membranous margin along anterior edge; lunules extending the length of frontal region. Lateral cephalothoracic margin slightly irregular, with membrane extending laterally and second projecting medially, on ventral surface; small but distinct concavity present in posterior lateral surface. Posterior sinus (fig. 43*c*) narrower at opening than medially, with fine membrane along outer margin. Medial posterior margin of median cephalothoracic region smoothly convex, projecting posteriorly slightly past rounded lateral margins of median region and slightly past posterior end of lateral cephalothoracic regions. Dorsal cephalothoracic surface with numerous small, hairlike processes; major dorsal grooves forming irregular H. Ocular region distinct, in anterior third of cephalothorax; pigmented cups contiguous on median longitudinal axis of body.

Female free fourth pedigerous segment distinct from cephalothorax, indistinctly separable from genital segment dorsally, distinctly separable laterally and ventrally. Segment broad medially, in region of fourth leg attachment, narrower anteriorly and posteriorly. Genital segment (fig. 43*d*) with anterior end narrow, anterior lateral margins convex; posterior lateral surfaces forming pair of posteriorly projecting lobes. Fifth legs (fig. 43*f*) not visible dorsally, situated on lateral ventral surface, at base of lobes; consisting of pair of knobs, outermost with single plumose setule, innermost with 2 plumose set-

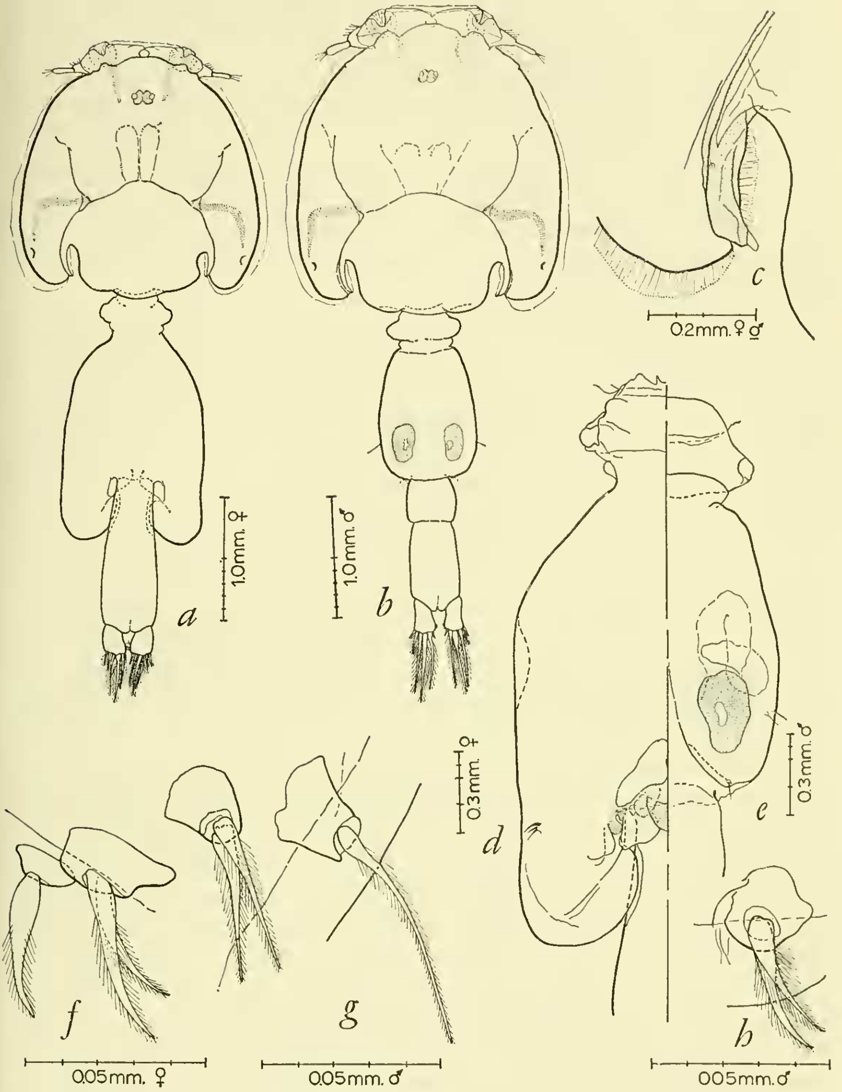


FIGURE 43.—*Caligus productus* Dana, 1853, dorsal view: *a*, female; *b*, male; *c*, posterior cephalothoracic sinus. Ventral view: *d*, female genital segment; *e*, male, same. Legs: *f*, female fifth; *g*, male fifth; *h*, male sixth.

ules. Abdomen 1-segmented, elongate, indistinctly separable from genital segment; with small concavity in anterior-ventral lateral surface, concavity giving 2-segmented appearance but no complete division indicated, either by cuticle or musculature. Posterior half of abdomen broader than anterior, posterior margin angled laterally, with anal concavity medially. Caudal rami (fig. 45*h*) width approximately nine-tenths the length, narrower proximally than distally, distal half of inner margin plumose. Distal surface bearing 3 large plumose setae medially, smaller plumose seta laterally and 2 plumose setules, 1 on either side of setae.

Male cephalothorax (fig. 43*b*) similar to that of female although slightly larger. Free fourth pedigerous segment with small, plate-like lateral extensions of tergal region, attached anteriorly to place of fourth leg attachment. Genital segment (fig. 43*e*) distinct from fourth pedigerous segment, barrel shaped, posterior surface slightly irregular, ventral surface with padlike swelling posteriorly. Fifth leg (fig. 43*g*) situated on lateral ventral surface in posterior half of segment, similar to that of female; sixth leg (fig. 43*h*) situated on posterior ventral surface, consisting of nodule bearing 2 plumose setules. Abdomen 2-segmented, distinct from genital segment dorsally, indistinctly separable ventrally. First segment approximately five-ninths the length of second, subrectangular; second segment slightly narrower anteriorly than posteriorly, posterior end similar to that of female. Caudal rami as in female.

Female and male antennule (fig. 44*b*) 2-segmented, attached to lateral-anterior ventral cephalothoracic surface. First segment approximately 1½ times the length of second, broad proximally, distal half of anterior surface angled to narrow distal surface, bearing approximately 25 plumose setae and setules. Second segment rod shaped, rounded distally, distal surface bearing approximately 12 naked setae and setules. Female antenna (fig. 44*c*) 3-segmented, situated medial and posterior to antennule base. First segment short, squat, almost completely fused with cephalothorax, with spikelike posterior projection. Second segment broad proximally, narrower distally; third segment fused with clawlike terminal process, bearing setule-like accessory process proximally. Male antenna (fig. 44*d*) 3-segmented; first segment of each antenna in close proximity, structurally similar to female first segment although spinelike projection smaller. Second segment elongate, with adhesion surface extending as band in median third of segment, segment also bearing spike-shaped projection from distal third of inner surface, projection with adhesion surface. Third segment indistinctly separable from clawlike terminal process, with setule-like accessory process proximally.

Female and male mandible (fig. 44*c*) 4-parted, distal part curved

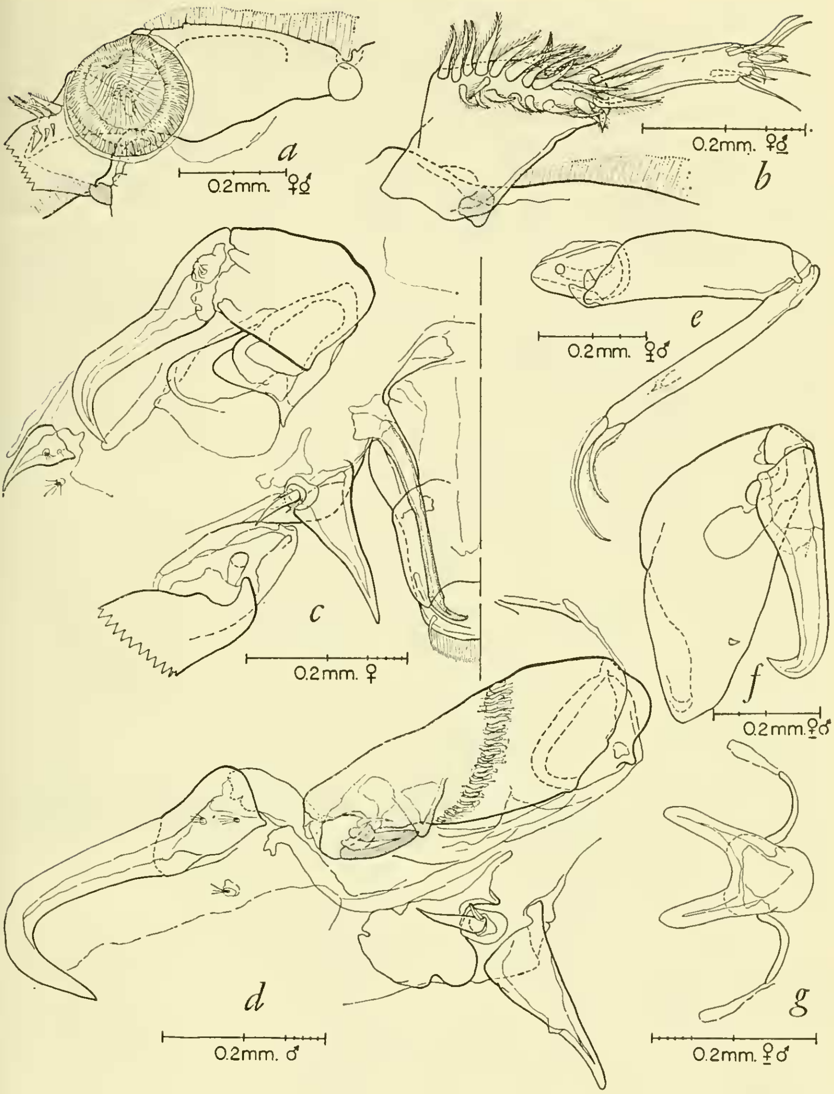


FIGURE 44.—*Caligus productus* Dana, 1853, ventral view: *a*, frontal region, right side showing lunule; *b*, left antennule; *c*, female oral region, right side showing antenna, postantennal process, mouth cone, mandible, maxillule, postoral process, and maxilla base; *d*, male, same as *c* except mouth cone, mandible, and maxilla base not shown; *e*, left maxilla; *f*, right maxilliped; *g*, sternal furca.

inward, inner surface with 12 denticulations. Female postantennal process (fig. 44*c*) short, clawlike, with 2 nodules on proximal surface and additional nodule just posterior to clawlike projection, all 3 nodules with several hairlike processes. Postantennal process of male (fig. 44*d*) much longer than that of female, recurved; nodules and hairlike processes as in female. Female postoral process (fig. 44*c*) long, spinelike; male (fig. 44*d*) as in female except for small, knoblike projection on outer medial surface. Female and male maxillule (figs. 44*c*, *d*) nodular, with 3 setules. Female and male maxilla (fig. 44*e*) 2-segmented, situated lateral and slightly posterior to postoral process. First segment slightly shorter than second, second rodlike, with fine membrane on posterior surface of distal half of segment and 2 saber-like terminal processes. Innermost terminal process approximately 1½ times the length of outermost, with fine membrane along inner margin; outermost process with finely frilled membrane along both margins.

Female and male maxilliped (fig. 44*f*) 2-segmented, situated posterior and medial to maxilla base. First segment strongly developed, narrow proximally and distally, broad medially, with small, spinelike projection from proximal half of inner surface. Second segment short, distinct from clawlike terminal process, with small, setule-like accessory process from distal inner surface. Female and male sternal furca (fig. 44*g*) situated on median longitudinal axis posterior to maxilliped bases. Tines diverging, rounded distally.

Second segment of exopodite of first leg without large plumose setae along inner margin but with 3 minute projections in position normally occupied by setae. For nature of legs and armature, see figures 45*a–g* and table 16.

TABLE 16.—*Armature of thoracic legs I–IV of the female and male of* Caligus productus *Dana, 1852*

Leg	Surface	Interpodal Plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer		2s*,p		rh	H,2dH,dP′				
	Inner		d,p		C,C	3s				
II	Outer	m		m,p	m,mH	mH	mH,2Q	C	D	3P
	Inner		2s,P	m,s	c,P	c,P	c,5P	P	c,2P	c,3P
III	Outer	m	d,m,p		s,H	c,p′	c,3p′,P	c	c,2P	
	Inner		d,3s,P,s,m,s			c,P	c,3P	P	c,4P	
IV	Outer		4s,p		4s,dmH†	2dmH,2H				

* More than one hairlike process.
† Very fine denticulations on membrane.

DISCUSSION.—The synonymy does not show several references included by Shiino (1959b) (Rathbun, 1884; Wilson, 1935a), and

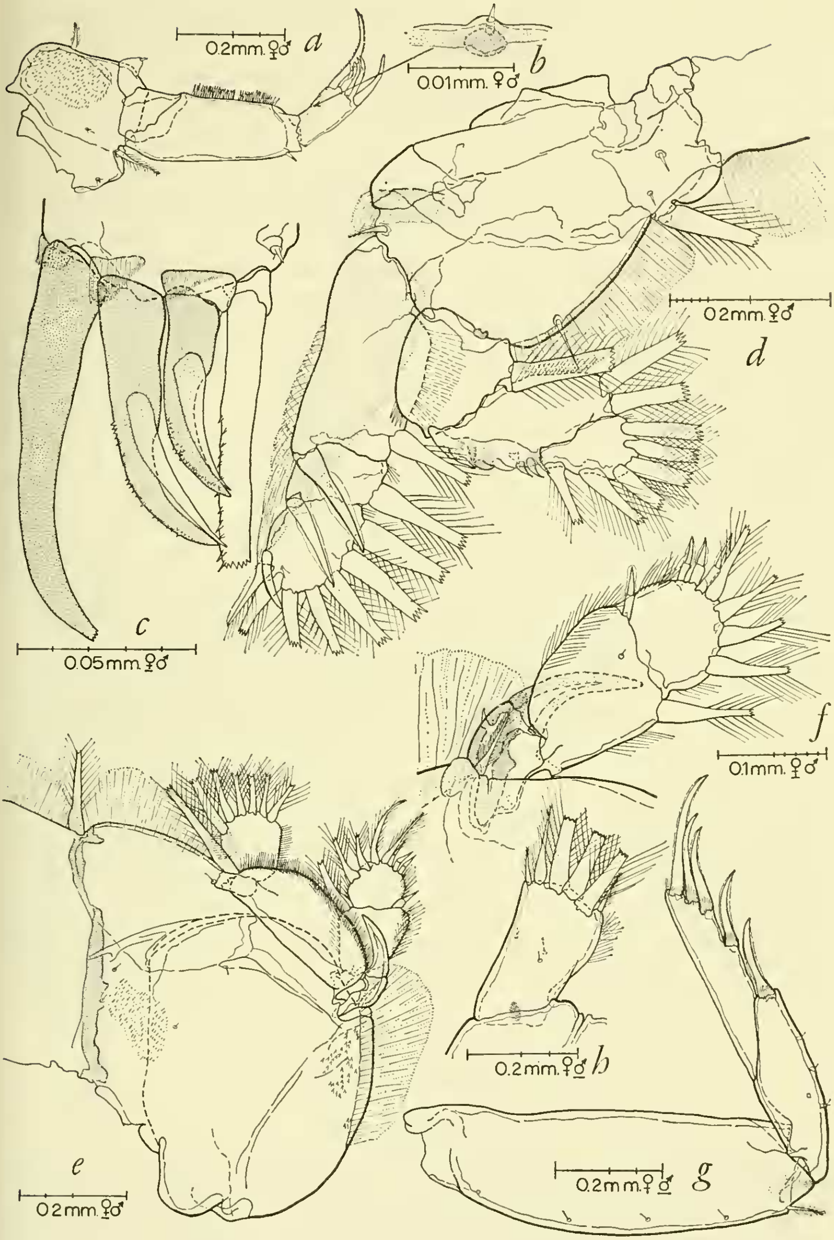


FIGURE 45.—*Caligus productus* Dana, 1853, right thoracic legs: *a*, first, anterior view; *b*, proximalmost setule on inner margin of second segment of exopodite of first; *c*, distal region of second segment of exopodite of first, anterior view; *d*, second, anterior view; *e*, third, anterior view; *f*, exopodite of third, posterior view; *g*, fourth, anterior view; *h*, caudal ramus, ventral view.

Wilson's 1937 reference ("*C. monacanthi*") is changed. In an examination of the material identified by Rathbun as *Caligus productus* (USNM 6109) for his 1884 publication, all of the specimens were found to belong to *C. quadratus* Shiino. The female specimen that Wilson (1935a) identified as *C. productus* (USNM 69776) is not *C. productus* and does not belong to either of the 2 closely related species here described. The material that Wilson (1937) described as *C. monacanthi* from Panama Bay (USNM 69867, 69868) is all *C. productus*. Shiino (1959b) indicates that the males identified as *C. monacanthi* by Wilson are *C. quadratus* and the females *C. productus*. This indication is presumably based on Wilson's statement (1937, p. 426) that "the terminal segment of the first legs [of the male] carries the usual 3 plumose setae on its posterior margin." This indicates that the males are not *C. productus* inasmuch as the absence of the 3 setae is characteristic of this species. From an examination of Wilson's material, however, it was found that the males as well as the females do not possess any plumose setae on the posterior margin of the second (terminal) segment of the exopodite of the first thoracic leg. Additionally, all of these specimens have other characteristics that associate them with *C. productus*. An examination of the type material for *C. lobatus* Wilson, 1935a (USNM 64059, 64060) supports Shiino's conclusion that this species is also a synonym of *C. productus*.

The species described as *Caligus dentatus* Heegaard, 1962, shows some of the characteristics found in *C. productus*, particularly the absence of plumose setae on the second segment of the exopodite of the first thoracic leg. Whether this species is synonymous with *C. productus* or is distinct remains questionable, and further, undamaged material should be adequately described, figured, and compared with associated species before the relationship can be realized.

For a comparison of *C. productus* with closely related species found in Hawaiian waters, see the discussion section following the description of the following species.

Caligus bonito Wilson

Figures 46–48

Caligus bonito Wilson, 1905b, p. 589, pl. 13, figs. 150–153, text figs. 5, 12–15, 29, 30, 35, 37, 38, 40–45.—Rathbun, 1905, p. 89.—Brian, 1924, p. 13.—Wilson, 1932, p. 407, fig. 255.—Brian, 1935, p. 188, fig. 14.—Yamaguti, 1936a, p. 8, pl. 5, figs. 69–71; pl. 6, figs. 72–85.—Bere, 1936, p. 582.—Causey, 1953a, p. 4; 1953b, p. 8.—Nunes-Ruivo, 1956, p. 6, pl. 2, fig. a.—Causey, 1960, p. 328.—Shiino, 1960b, p. 527, fig. 1; 1963a, p. 336.—Yamaguti, 1963, p. 50, pl. 56, fig. 3.

?*Caligus kuroshio* Shiino, 1959c, p. 51, figs. 1–2.—Pillai, 1963, p. 80, fig. 9.—Yamaguti, 1963, p. 55, pl. 71, fig. 3.

DISTRIBUTION AND HOSTS.—20 host records:

locality	*hosts*	*references*
Western North Atlantic	Bonito	Wilson, 1905b
	Gymnosarda pelamis	Rathbun, 1905
Subtropical Atlantic	*Cybium*	Brian, 1924
	Katsuwonus pelamis	Nunes-Ruivo, 1956
Gulf of Mexico	*Pomatomas saltatrix*	
	Scomberomorus maculatus	
	Lutianus griseus	
	Mugil cephalus	
	Oligoplites saurus	
	Scomberomorus cavalla	Bere, 1936
	Gymnosarda alleterato	Causey, 1953a
	Sarda sarda	Causey, 1953b
Eastern Pacific	*Sarda chilensis*	
	?*Lutjanus* species	Causey, 1960
	Katsuwonus pelamis	Shiino, 1963a
Japan	*Euthynnus pelamis*	Yamaguti, 1936a
	Katsuwonus pelamis	
	Thunnus thynnus	Shiino, 1959c
Indian Ocean	*Euthynnus affinis*	Pillai, 1963
Mediterranean	*Pelamys sarda*	Brian, 1935

MATERIAL.—Three females (USNM 112911) from the gill cavity of several specimens of *Katsuwonus pelamis* (Linnaeus.) captured 100 miles north of Oahu, Hawaii (USFWS).

MEASUREMENTS.—(In mm) 3 females:

Total length, excluding caudal setae	6.20, 6.50, 6.45
Length of cephalothorax, including frontal region	2.70, 3.05, 3.10
Width of cephalothorax	2.50, 2.85, 2.85
Length of genital segment	2.00, 2.05, 2.00
Width of genital segment	1.50, 1.35, 1.60
Length of abdomen	1.25, 1.35, 1.25
Length of caudal rami	0.19, 0.20, 0.22
Length of egg strings (all 3 nonovigerous)	

DESCRIPTION OF FEMALE.—Cephalothorax (fig. 46*a*) ovoid, consisting of cephalon and first 4 thoracic segments. Frontal region approximately one-tenth the total length of cephalothorax, with fine membrane along anterior margin. Lunules distinct, slightly longer than greatest length of frontal region. Lateral cephalothoracic margin slightly irregular, with narrow membrane projecting laterally and second projecting medially. Posterior lateral surface with small indentation. Posterior sinus (fig. 46*b*) U-shaped, with fine membrane along outer margin. Posterior medial surface extending posteriorly slightly past lateral cephalothoracic regions, with narrow, median projection covering junction of cephalothorax and free fourth pedigerous segment. Major dorsal cephalothoracic grooves forming irregular H, transverse groove of H distinct, irregular. Ocular elements distinct, contiguous on median longitudinal axis of body, in anterior third of cephalothorax.

Free fourth pedigerous segment wedge shaped, distinctly separable from genital segment ventrally, appearing fused dorsally. Genital segment (fig. 46*c*) constricted anteriorly, with pair of lobate projections posteriorly, distinct from abdomen. Fifth legs (fig. 46*d*)

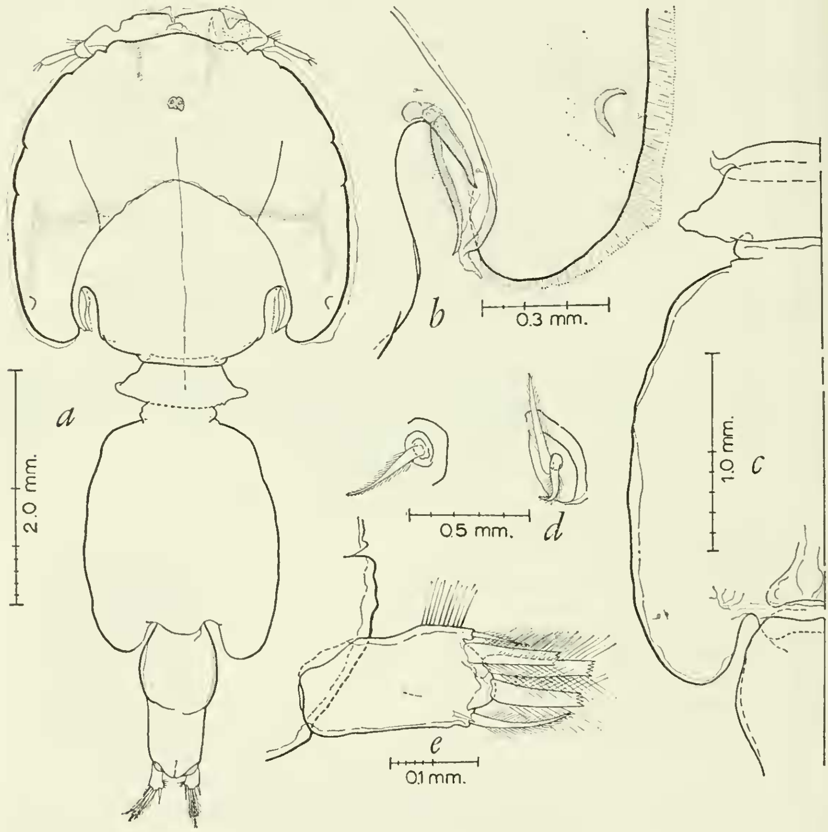


FIGURE 46.—*Caligus bonito* Wilson, 1905, female: *a*, dorsal view; *b*, posterior cephalothoracic sinus, dorsal view. Ventral view: *c*, free fourth pedigerous segment, genital segment, and anterior region of abdomen; *d*, right fifth leg; *e*, caudal ramus.

minute, situated on ventral posterior lateral surface, consisting of single, lightly plumose setule laterally, pair of lightly plumose setules just medial to lateral setule.

Abdomen 1-segmented, anterior half appearing swollen, degree of swelling varying in 3 Hawaiian specimens. Posterior half of abdomen rounded on dorsal posterior surface, with pair of concavities on ventral surface forming place of attachment of caudal rami, anal indentation slight. Caudal rami (fig. 46*e*) narrower proximally than distally, distal half of inner surface slightly swollen, swelling terminating posteriorly in slight knob bearing plumose setule. Distal inner margin plumose, distal surface with 3 plumose setae originating ventral

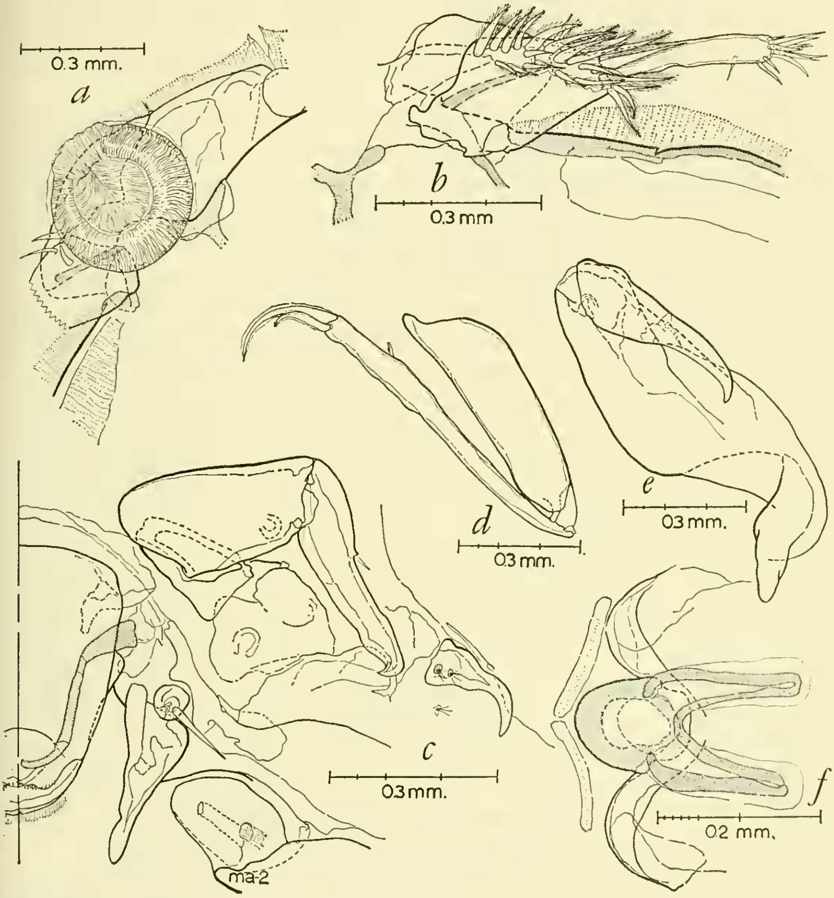


FIGURE 47.—*Caligus bonito* Wilson, 1905, female, ventral view: *a*, right side of frontal region showing lunule and antennule base; *b*, left antennule; *c*, oral region, left side showing antenna, postantennal process, mouth cone, mandible, maxillule, postoral process, and maxilla base (ma-2); *d*, left maxilla; *e*, left maxilliped; *f*, sternal furca.

to small median lobe, plumose setule present lateral to setae and 2 minute setules present, 1 on each side of ramus.

Antennule (fig. 47*b*) 2-segmented, attached to lateral-anterior ventral surface of cephalothorax and lateral-posterior ventral surface of frontal region. First segment slightly longer than second, proximal half broad, distal tapered to narrow distal end, anterior ventral surface with approximately 23 plumose setae and setules, anterior dorsal surface with pair of plumose setules. Second segment rodlike, with approximately 12 naked setules distally. Antenna (fig. 47*c*) 3-segmented, situated posterior and medial to antennule base. First segment short, squat; second segment broad proximally, tapered to lightly narrower distal end, with small, horseshoe-like projection on lateral anterior surface in distal half of segment. Third segment and clawlike terminal process fused, single setule-like accessory process present.

Mandible (fig. 47*c*) 4-parted, rodlike, distalmost part curved medially, with 12 denticulations on inner surface. Labrum with minute denticulations on distal surface. Postantennal process (fig. 47*c*) situated lateral to antenna base, consisting of clawlike process and 3 nodules, each with several hairlike processes. Postoral process (fig. 47*c*) long, spinelike, distal end flattened slightly, appearing spade shaped. Maxillule (fig. 47*c*) nodular, with 3 setules. Maxilla (fig. 47*d*) 2-segmented, situated lateral and slightly posterior to postoral process. First segment approximately four-fifths the length of second; second elongate, slightly swollen medially, with fine membrane on medial swelling and 2 saber-shaped terminal processes. Innermost terminal process approximately twice length of outer, with fine membrane along both margins; outer terminal process with frilled membrane along outer margin.

Maxilliped (fig. 47*e*) 2-segmented, situated posterior and medial to maxilla base. First segment strongly developed, proximal half tapered to narrow proximal end, curved strongly; distal half tapered to irregular distal end. Second segment short, separable from clawlike terminal process, bearing single setule-like accessory process from distal inner surface. Sternal furca (fig. 47*f*) situated on median longitudinal axis of body approximately halfway between maxilliped bases and first thoracic legs. Tines chisel shaped, diverging slightly; furca attached to small, platelike projection.

For nature of legs and armature, see figure 48 and table 17.

Discussion.—The Hawaiian material differs from the original description of *Caligus bonito* Wilson, 1905b, in one major respect, the longer abdomen of *C. bonito*. In an examination of the type material of *C. bonito* (USNM 6035, 41975) considerable variation was noted in both the length and width of the abdomen. This variation appears to be due to the maturity of the specimens. The length of the region posterior to the swollen anterior portion of the abdomen of the Hawaiian specimens approximates the length of the region behind the slight constriction (joint between segments) of the abdomen of *C. bonito*. Based upon this, upon the absence of egg strings in the Hawaiian material (although formative strings are present in the

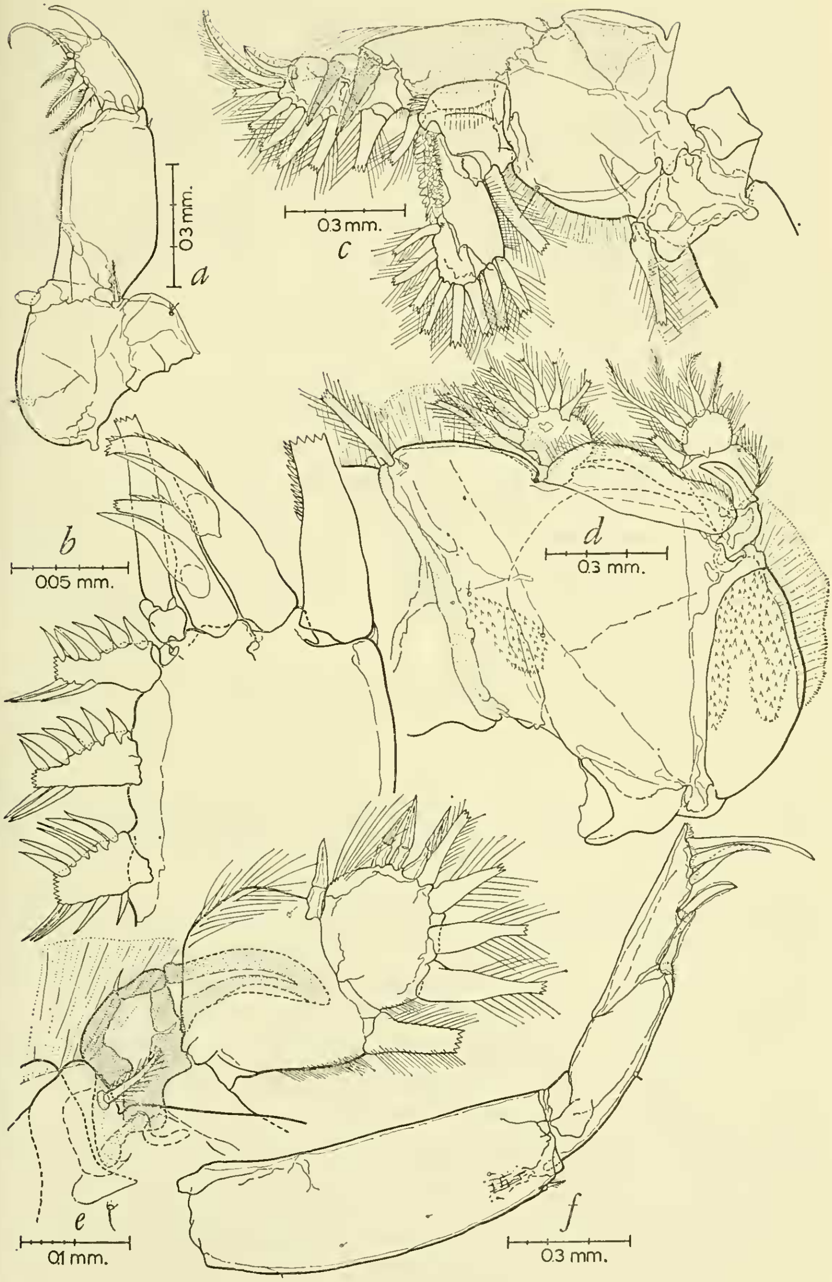


FIGURE 48.—*Caligus bonito* Wilson, 1905, right thoracic legs, anterior view: *a*, first; *b*. second segment of exopodite of first; *c*, second; *d*, third; *e*, exopodite of third (posterior view); *f*, fourth.

TABLE 17.—*Armature of thoracic legs I–IV of the female of* Caligus bonito *Wilson, 1905b*

Leg	Surface	Interpodal Plate	Protopodite 1	Protopodite 2	Exopodite 1	Exopodite 2	Exopodite 3	Endopodite 1	Endopodite 2	Endopodite 3
I	Outer		s,p		rh	3dH,P′				
	Inner		p		c	3P				
II	Outer	m		m,p	m,fm,mH	mH	fmH,mH, Q,P	C	D	D,4P
	Inner		s,P	m,s	c,P	c,P	4P	P	c,2P	c,2P
III	Outer		d,m,p		s,H	c,s,p′	c,3p′,P	c	c	
	Inner	m	d,2s,P,s, m,s			c,P	c,3P	P	c,6P	
IV	Outer		5s,p		s,fm,mH	fm,mH,3fm, 3H				

genital segment), upon the change that occurs in the length of the abdomen in other species (e.g., *Caligus coryphaenae*), and upon Wilson's statement (1905b, p. 589) that "the joints [are] about equal in immature females" (the 2-segmented condition is not evident in the Hawaiian specimens), the present author feels that the difference in the length of the abdomen between the Hawaiian material and Wilson's original description of *C. bonito* is due to the immature condition of the Hawaiian specimens.

The differences between the Hawaiian specimens and *Caligus kuroshio* Shiino, 1959c, are primarily differences in the small armature elements of the appendages. The caudal rami of the Hawaiian specimens possess a small, nodular projection on the inner distal surface that bears a plumose setule while Shiino's figure does not show the nodule. Shiino indicates (table I) that there is a large, plumose seta on the second segment of the protopodite of the second thoracic leg which is not present in the Hawaiian specimens; however, he does not figure this armature element and its presence would make *C. kuroshio* unique. Shiino describes a 2-segmented condition for the exopodite of the third thoracic leg while the present author describes a 3-segmented condition for the Hawaiian specimens of *C. bonito*. Shiino's "first segment" is what the present author calls segments 1 and 2. The large, inwardly curved spine is at the distal end of the first segment (fig. 48*e*) while the plumose seta and naked setule (1h in Shiino's table I) are on the second segment. Shiino also uses the smaller size of his specimens to differentiate *C. kuroshio* from *C. bonito*. The size of Wilson's holotype female is 8.3 mm, the largest specimen in Shiino's 1959c description is 6.92 mm (range 5.39–6.92), Yamaguti (1936a, *C. bonito*) lists 4.5–5.6 mm, Brian (1935, *C. bonito*) lists 8mm, Brian (1924, *C. bonito*) lists 4,5,7 and 8 mm females, and a male at 5 mm, Shiino (1960b, *C. bonito*) gives the largest female at 6.7 mm, while the Hawaiian female specimens range from 6.2–6.5 mm.

Remarks.—*Caligus quadratus*, *C. productus*, and *C. bonito* are difficult to separate not only because of the similarity in their morphology but also because they are found on the same species of hosts and not too infrequently they may be on the same host specimen. Although this leads to some speculation on the relationships of the three, there is some evidence to support the belief that they are distinct species. This evidence, or part of it, can be used to separate the species without going through a complete morphological analysis. Assuming that the general body shape and number of segments in the thoracic legs agrees with the figures (i.e., that the specimens belong to this species complex), *Caligus productus* can be separated by the absence of the 3 plumose setae normally present on the inner margin of the second segment of the exopodite of the first thoracic leg. Both *Caligus quadratus* and *C. bonito* possess these 3 setae, but *C. bonito* possesses a series of distinct denticulations on the outer margin of the first and second segments of the endopodite of the second thoracic leg. *Caligus quadratus*, on the other hand, possesses a patch of stiff plumosities in the same region. The difference between stiff plumosities and denticulations is not great but it is a distinct difference and sufficiently diagnostic to be used as a key characteristic.

Caligus asymmetricus, Kabata 1965b

Figures 49–51

Caligus thynni Pillai, 1963, p. 89, fig. 14.
Caligus asymmetricus Kabata, 1965b, p. 110, figs. 1B, D, E.
Caligus asymmetricus Pillai.—Kabata, 1965b, pp. 109, 110.

Distribution and host.—Trivandrum, South India, *Euthynnus affinis* (*in* Pillai, 1963); Queensland, Australia, *Euthynnus alleteratus* (*in* Kabata, 1956b).

Remarks.—Dana (1853, p. 1353) described the caligid *Caligus thymni* "from the external surface of a Bonito (*Thymnus pelamys*) . . . ." Presumably the species was named after the host although the spelling of the generic part of the host name (*Thymnus*) has, to my knowledge, never been used in the taxonomy of the tunas, the name being *Thynnus*. The name *Caligus thymni* again appears (p. 219) in a handwritten "Catalogue of Crustacea of the U.S. Expl. Exped. during 1838–'42 . . . collected and described by James D. Dana. Geologist and Zoologist Exp.," dated 1856 by Dana and located in the U.S. National Museum. Yamaguti (1963, p. 61) uses "*C. thymni* [misprint for *thynni*] Dana, 1853 . . ." in his account. It is highly probable that *thymni* was not a misprint but a lapsus by Dana, based on his erroneous spelling, *Thymnus*, of the host

Thynnus. In either case, *Caligus thymnus* is an incorrect original spelling and must be emended to *Caligus thynni* Dana. *Caligus thynni* Pillai (1963), a distinct species from *Euthynnus affinis*, thereby becomes a junior homonym.

After the publication of *Caligus thynni* Pillai, the author of the name became aware of the problem of homonymy and submitted a manuscript ("Copepods parasitic on Indian marine fishes—a review") containing the replacement name *Caligus asymmetricus*. During this period, however, specimens of the species had also been found on a fish captured near Green Island, Queensland, Australia, and had been submitted to Z. Kabata for identification. After corresponding with Pillai and learning of the replacement name that was then in press, Kabata submitted a manuscript containing the replacement name as well as a description of the species. It is unfortunate that the manuscript containing Pillai's replacement name was not published prior to the publication of Kabata's manuscript. Since, however, Kabata (1965b) was the first to publish the replacement name, he, therefore, becomes the author of that name.

The present author deeply appreciates the helpful correspondence with Dr. Pillai and the discussion with Dr. Kabata concerning some of the above details.

Material.—One adult female and 3 males (USNM 112912) from the external surface of *Euthynnus yaito* (Jordan and Evermann) captured off Moku Manu Island, near Oahu, Hawaii. One adult female (USNM 112913) from the gill cavity of *Euthynnus yaito* (Jordan and Evermann) captured at French Frigate Shoals (USFWS, HMS cruise 39, station 32).

Measurements.—(In mm) 2 females and 3 males:

	female	*male*
Total length, excluding caudal setae	3. 00, 3. 35	3. 15, 2. 80, 2. 55
Length of cephalothorax, including frontal region	1. 95, 2. 05	2. 03, 1. 88, 1. 68
Width of cephalothorax	1. 58, 1. 65	1. 55, 1. 53, 1. 30
Length of genital segment	0. 80, 0. 90	0. 60, 0. 55, 0. 50
Width of genital segment	0. 70, 0. 83	0. 53, 0. 55, 0. 48
Length of abdomen	0. 31, 0. 34	0. 41, 0. 37, 0. 33
Length of caudal rami	0. 11, 0. 11	0. 13, 0. 11, 0. 10
Length of egg strings (neither female ovigerous)		

Description.—Female cephalothorax (fig. 49*a*) ovoid, consisting of cephalon and first 4 thoracic segments. Frontal region approximately one-thirteenth the greatest length of cephalothorax, with fine membrane along anterior margin and pair of lunules overlapping division between frontal region and remaining cephalothorax ventrally. Lateral margin of cephalothorax slightly irregular, with fine membrane projecting laterally and second membrane projecting medially on ventral surface. Posterior lateral surface with small but

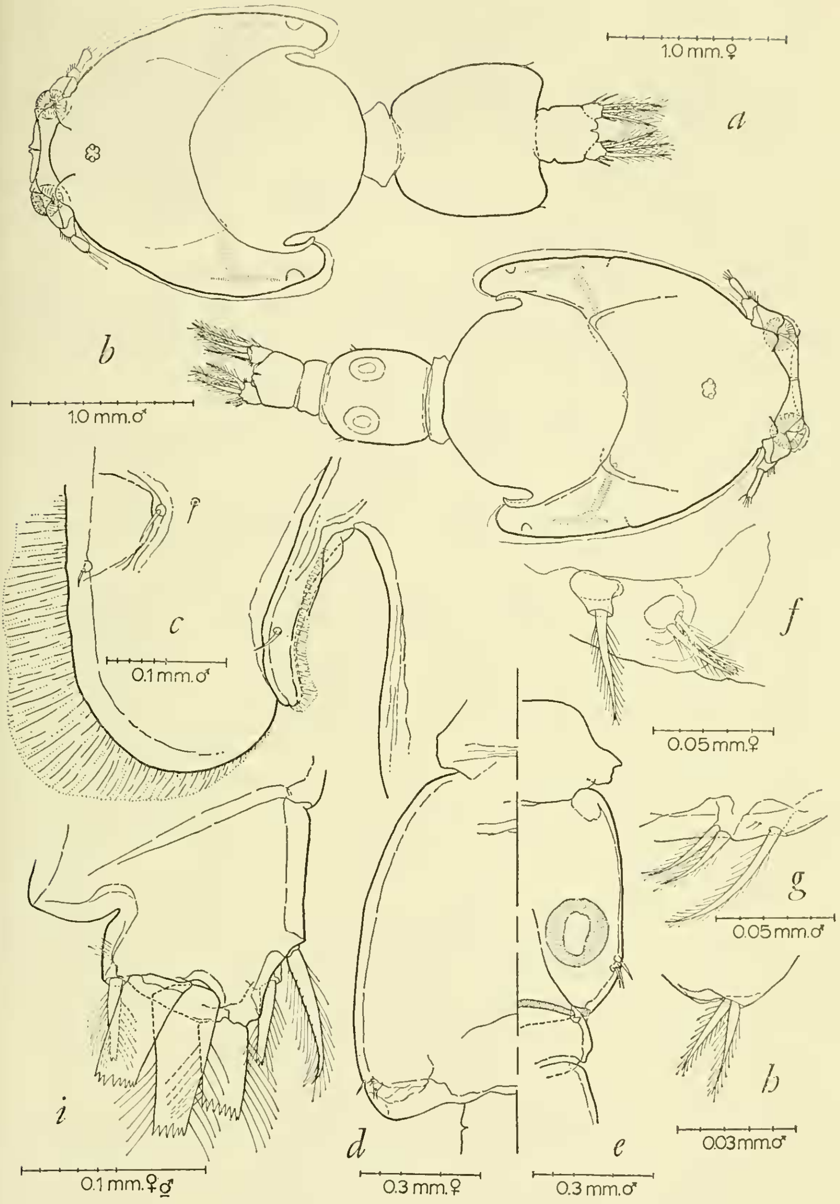


FIGURE 49.—*Caligus asymmetricus* Kabata, 1965b, dorsal view: *a*, female; *b*, male; *c*, posterior cephalothoracic sinus. Ventral view: *d*, female genital segment; *e*, male, same; *f*, female right fifth leg; *g*, male left fifth leg; *h*, male left sixth leg; *i*, caudal ramus.

distinct concavity. Posterior sinus (fig. 49*c*) narrow, bearing fine membrane along outer surface. Posterior median cephalothoracic region broadly convex, projecting posteriorly well past posterior lateral cephalothoracic region, overlapping anterior end of free fourth pedigerous segment. Major dorsal cephalothoracic grooves forming irregular H; dorsal surface with several spinules. Ocular region distinct, pigmented cups contiguous on median longitudinal axis in anterior third of cephalothorax.

Female free fourth pedigerous segment wedge shaped, irregular posteriorly, indistinctly separable from genital segment. Genital segment (fig. 49*d*) narrower anteriorly than posteriorly, lateral margins flatly convex, posterior flatly concave. Fifth legs (fig. 49*f*) situated on ventral-posterior lateral surface, consisting of pair of knobs, anteriormost with single plumose setule, posterior with 2 plumose setules.

Female abdomen indistinctly separable from genital segment, consisting of 1 or 2 segments. Indication of 2-segmented condition given by constriction anteriorly although indication superficial. Posterior two-thirds of abdomen subrectangular, posterior end tapered at junction with caudal rami, indented at anal opening. Caudal rami (fig. 49*i*) short, division between abdomen and rami incomplete. Lateral margins of rami essentially parallel, distal surface irregular, with 3 large plumose setae medially, 2 plumose setules on outer surface and 1 on inner surface; inner lateral margin of rami lightly plumose distally.

Male cephalothorax (fig. 49*b*) and free fourth pedigerous segment as in female although fourth pedigerous segment of figured male retracted under median posterior region of cephalothorax more than in female. Genital segment (fig. 49*e*) barrel shaped, distinct from both fourth pedigerous segment and abdomen. Fifth legs (fig. 49*g*) situated on posterior half of lateral surface, consisting of 3 plumose setules grouped as in female but without knobs. Sixth legs (fig. 49*h*) on slight ventral swelling posterior and medial to fifth legs, consisting of 2 plumose setules. Abdomen distinctly 2-segmented, first segment short, slightly more than half the length of second, second as in posterior two-thirds of female abdomen. Caudal rami as in female.

Female and male antennule (fig. 50*b*) 2-segmented, attached to lateral-anterior ventral surface of cephalothorax and lateral-posterior ventral surface of frontal region. First segment approximately 1½ times the length of second, broad medially, narrower proximally and distally, distal two-thirds of anterior and anterior ventral surface bearing approximately 26 lightly plumose setae and setules, including 1 long, anteriorly projecting seta. Second segment club shaped, bearing approximately 12 naked setae and setules distally, including 5 long setae (length slightly shorter than length of segment). Female antenna (fig. 50*c*) 3-segmented, situated posterior and medial to anten-

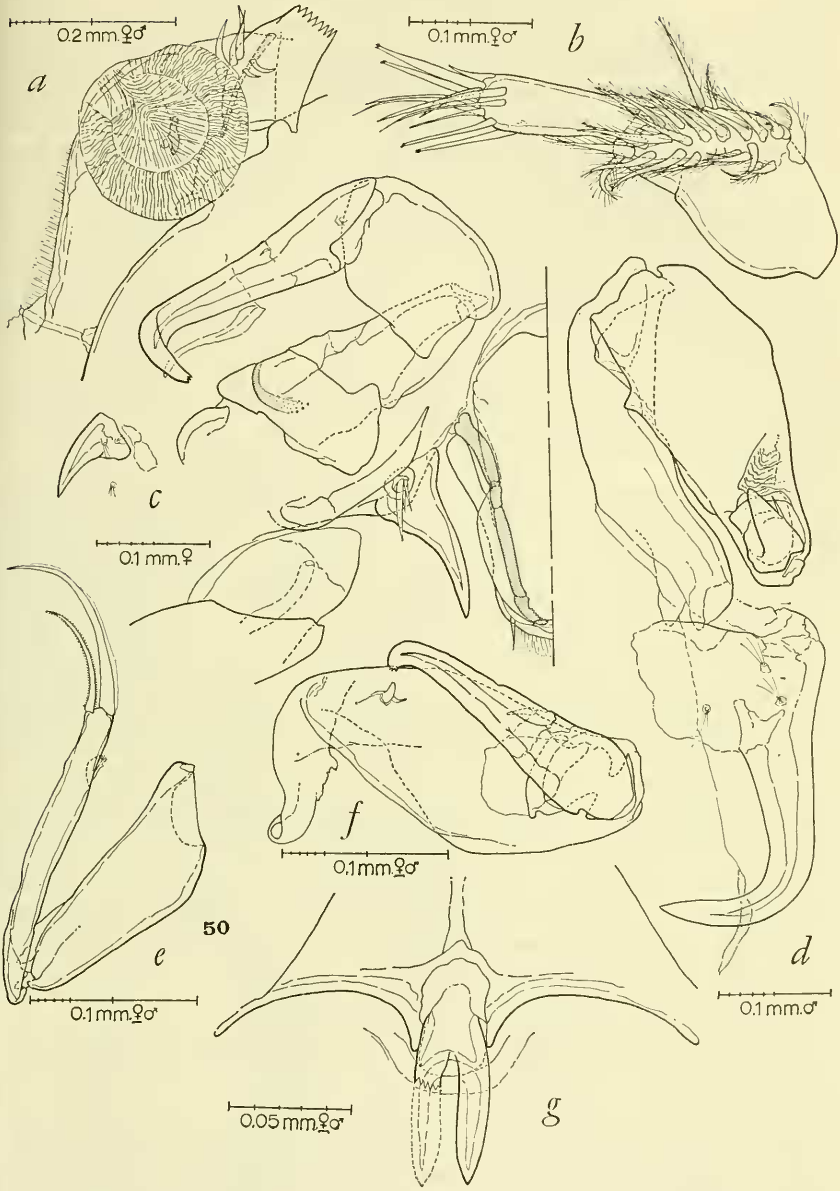


FIGURE 50.—*Caligus asymmetricus* Kabata 1965b, ventral view: *a*, frontal region, left side, showing lunule and antennule base; *b*, right antennule; *c*, female oral region, right side showing antenna, postantennal process, mouth cone, mandible, maxillule, postoral process, and maxilla base; *d*, male left antenna and postantennal process; *e*, left maxilla; *f*, right maxilliped, *g*, sternal furca.

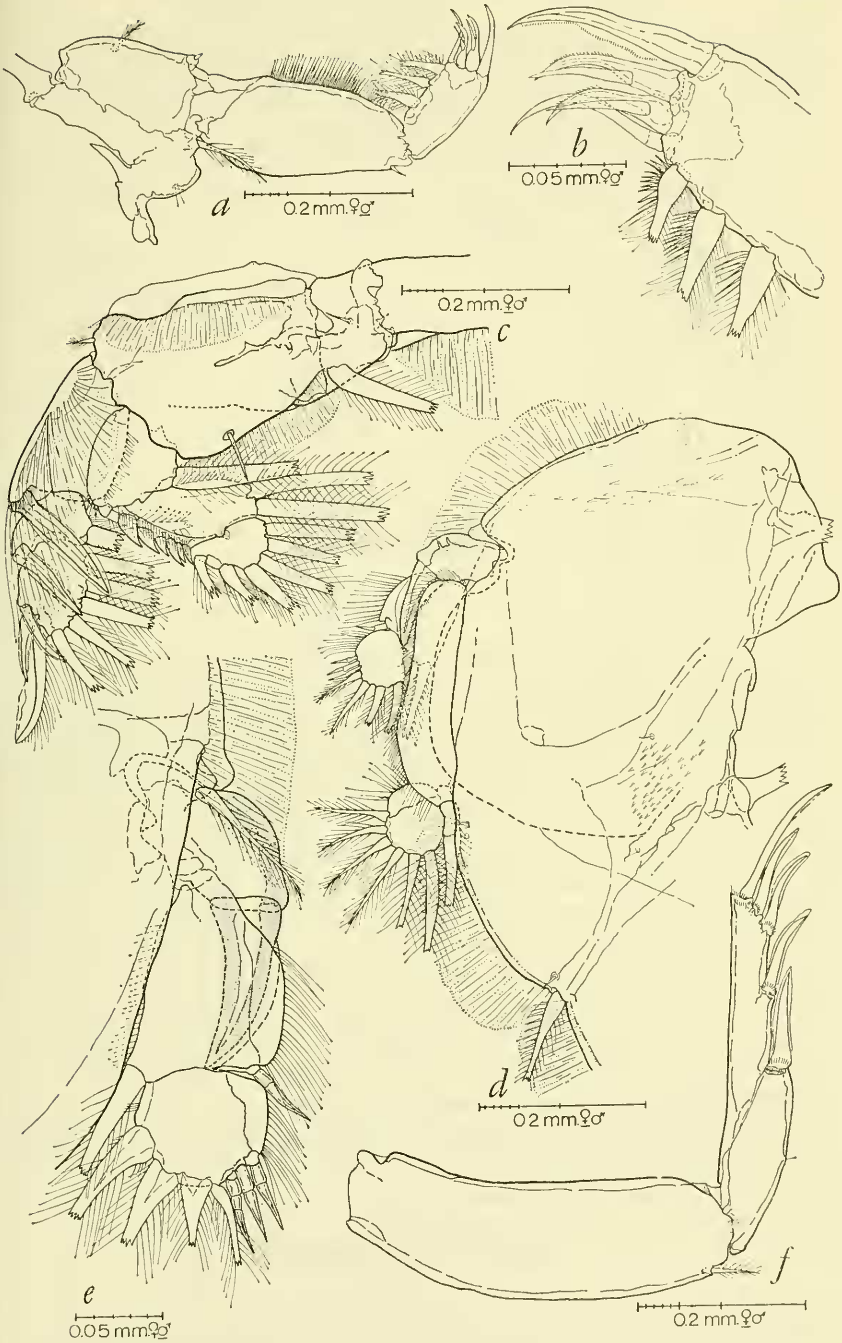
nule base. First segment short, squat, heavily sclerotized, with very slight indication of posterior projection at base; second segment slightly more than two-thirds as wide as long, narrower distally than proximally. Third segment fused with clawlike terminal process, bearing small, lappet-like projection on proximal posterior surface and small spinule-like accessory process at distinct break in sclerotization in proximal half of fused segment and terminal process. Male antenna (fig. 50*d*) 3-segmented, first segment elongate, heavily sclerotized, irregular; second segment shorter than first, broad proximally, tapered to narrower distal end, with ridged, lappet-like adhesion pad on distal inner surface, just proximal to third segment articulation surface and apparently receiving terminal process of third segment when segment flexed. Third segment fused with short, clawlike terminal process, bearing setule-like accessory process on anterior surface.

Female and male mandible (fig. 50*c*) 4-parted, distalmost part flattened, curved inward, with 12 denticulations along inner surface. Female postantennal process (fig. 50*c*) situated lateral to antenna, consisting of short, clawlike projection and 3 nodules, 2 on base of claw, third posterior to claw, each with several hairlike processes. Male postantennal process (fig. 50*d*) immediately lateral to antennal base, clawlike process much longer than in female and strongly curved distally, nodes as in female. Female and male postoral process (fig. 50*c*) long, spinelike, curved outward distally. Female and male maxillule (fig. 50*c*) nodular, with 3 setules. Female and male maxilla (fig. 50*e*) 2-segmented, situated lateral and slightly posterior to postoral process. First segment slightly shorter than second, more strongly developed; second segment elongate, tapered proximally, with fine membrane along inner medial surface and 2 saber-shaped terminal processes. Innermost terminal process slighty less then 1½ times the length of outermost, with fine membrane along inner margin; outermost process with finely frilled membrane along both margins.

Female and male maxilliped (fig. 50*f*) 2-segmented, situated posterior and medial to maxilla base. First segment strongly developed, broad medially, tapering proximally and distally, proximal end strongly curved, heavily sclerotized; small, subconical projection present on inner medial surface. Second segment distinct from clawlike terminal process, with setule-like accessory process on distal inner surface. Female and male sternal furca (fig. 50*g*) situated on median longitudinal axis of body, posterior to maxilliped bases. Base of furca

---

Figure 51.—*Caligus asymmetricus* Kabata, 1965b, right thoracic legs, anterior view: *a*, first; *b*, second segment of exopodite of first; *c*, second; *d*, third; *e*, exopodite of third (posterior view); *f*, fourth.


a
0.2 mm. ♀♂
b
0.05 mm. ♀♂
c
0.2 mm. ♀♂
d
0.2 mm. ♀♂
e
0.05 mm. ♀♂
f
0.2 mm. ♀♂

between 2 concave, lappet-like projections; tines sharply pointed, essentially parallel (right tine broken on figured female specimen, tines more irregular on second female specimen).

For nature of legs and armature, see figures 51*a–f* and table 18.

TABLE 18.—*Armature of thoracic legs I–IV of the female and male of* Caligus asymmetricus *Kabata, 1965b*

Leg	Surface	Interpodal Plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer		ss,p		rh	3fmH,P′				
	Inner		p		c,c	3P				
II	Outer	m		m,p	m,mH	mH	2mH,Q	C	D,c	c,3P
	Inner		s,P	m,s	c,P	c,P	5P	P	c,2P	3P
III	Outer	m	d,m,P		mH	c,p′	c,3p′,P	c	c,2P	
	Inner		d,2s,P,s, m,s			c,P	c,3P	P	4P	
IV	Outer		p		s,fm,mH	fm,mH, fm,mH, fm,H				

DISCUSSION.—The Hawaiian specimens differ from the original description of *Caligus asymmetricus* Kabata in several respects. The genital segment is more swollen, a characteristic that may be due to maturity. The tines of the sternal furca of the figured specimen are not quite as angular as those figured by Pillai (1963), although the tines on the other female are similar to Pillai's figure. The terminal processes of the exopodite of the first thoracic leg are structurally similar to those figured by Pillai but they are at the end of the segment, not subterminal as Pillai figures them. The denticulations on the outer margin of the second segment of the endopodite of the figured second thoracic legs differ in number (6 instead of 9) but not in character. There is, however, some variation in the number of denticulations in the Hawaiian material, even in the same specimen, the number ranging from 5–14 denticulations. Pillai (1963) based his description on 1 female specimen (nonovigerous?) from a specimen of *Euthynnus affinis* along with several specimens of *C. kuroshio* (=?*C. bonito* Wilson, 1905*b*), while the Hawaiian material came from a specimen of *Euthynnus yaito*.

Caligus pelamydis Krøyer

FIGURES 52, 53

Caligus pelamydis Krøyer, 1863, p. 124, pl. 4, fig. 4a–g.—Richiardi, 1880, p. 148.—Valle, 1882, p. 245.—Carus, 1885, p. 357.—Bassett-Smith, 1899, p. 452.—Brian, 1899b, p. 198.—Wilson, 1905b, p. 594, pl. 13, figs. 154–161; pl. 14, fig. 161a.—Brian, 1906, p. 43.—Brady, 1910, p. 589, fig. 69.—Stebbing, 1910,

p. 558.—Guiart, 1913, p. 7.—Scott and Scott, 1913, p. 57, pl. 7, figs. 2,3; pl. 9, figs. 1–5; pl. 71, fig. 14.—Scott, 1929, p. 89.—Wilson, 1932, p. 406, fig. 254.—Heegaard, 1943b, p. 5.—Causey, 1953a, p. 5; 1953b, p. 10; 1955, p. 4.—Nunes-Ruivo, 1956, p. 5, pl. 1, fig. a.—Barnard, 1955, p. 245.—Causey, 1960, p. 329.—Hewitt, 1963, p. 78, fig. 6.

Caligus scomberi Bassett-Smith, 1896b, p. 11, pl. 3, fig. 2; 1899, p. 450.

Caligus scombri Scott T., 1901, p. 148, pl. 5, fig. 9–10.—Scott A., 1906, p. 196, pl. 6.—Guiart, 1913, p. 6.

Distribution and hosts.—12 host records:

locality	*hosts*	*references*
North Atlantic	*Pelamys sarda*	Krøyer, 1863
	Scomber scombrus	Scott and Scott, 1913
East coast of North Atlantic	Unknown	Wilson, 1905b
South Atlantic	Unknown	Brady, 1910
		Stebbing, 1910
	Sarda sarda	Nunes-Ruivo, 1956
Gulf of Mexico	*Pogonias cromis*	
	Scomberomorus cavalla	Causey, 1953a
	Sarda sarda	Causey, 1953b
New Zealand	*Thyrsites atun*	Hewitt, 1963
Mediterranean	*Scomber scomber*	
	Pelamys sarda	Richiardi, 1880
	Unknown	Guiart, 1913

Material.—One female (USNM 112914) from the gill cavity of *Euthynnus yaito* (Jordan and Evermann) captured at French Frigate Shoals (USFWS, HMS cruise 39, station 32).

Measurements.—(In mm) 1 female:

Total length, excluding caudal setae	4.05
Length of cephalothorax, including frontal region	1.38
Width of cephalothorax	1.20
Length of genital segment	1.18
Width of genital segment	1.10
Length of abdomen	1.45
Length of caudal rami	0.17
Length of egg strings (female nonovigerous)	

Description of female.—Cephalothorax (fig. 52*a*) ovoid, consisting of cephalon and first 4 thoracic segments. Frontal region narrow, middle of anterior surface distinctly indented, margin with fine membrane. Lunules (fig. 52*f*) large but filmy, extending posteriorly, on ventral surface, past junction of frontal region and remaining cephalothorax. Lateral margin of cephalothorax slightly irregular, bearing fine membrane extending laterally and second extending medially on ventral surface. Posterior lateral cephalothoracic surface with small concavity. Posterior sinus (fig. 52*b*) narrow, constricted at opening, with fine membrane along outer surface. Posterior median cephalothoracic surface extending past lateral surface, posterior end overlapping junction of cephalothorax and free fourth pedigerous segment, margin flatly convex. Major dorsal cephalothoracic grooves forming irregular H, posterior longitudinal legs and crosssbar continuous, heavily sclerotized. Ocular region distinct.

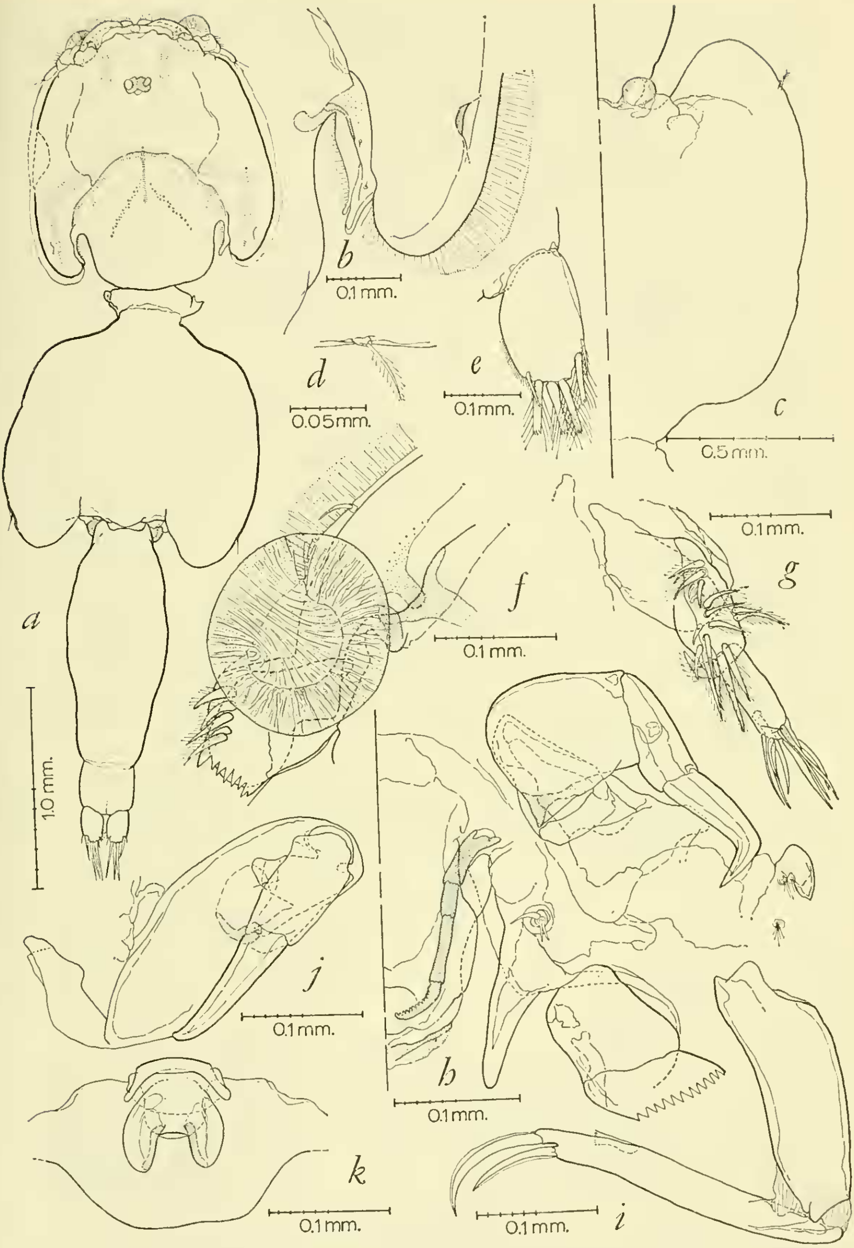
Free fourth pedigerous segment short, distinct from cephalothorax, incompletely separable from genital segment; segment sharply angled posteriorly and anteriorly, from region of fourth leg attachment. Genital segment (fig. 52*c*) broad for most of length, anterior end concavely angled inward, posterior end with pair of broad lappets dorsolaterally, lappets extending posteriorly past junction of genital segment and abdomen. Fifth legs (fig. 52*d*) consisting of single, plumose setule arising from ventral lateral surface at anterior end of lappets. Spermatophores visible on single Hawaiian specimen, attached immediately ventral to junction of genital segment and lateral surface of abdomen.

Abdomen indistinctly 2-segmented, junction with genital segment distinct. First segment approximately five times the length of second, broadest in anterior medial portion, irregularly curved to anterior and posterior ends; second segment with flatly convex lateral margins, anal indentation slight. Caudal rami (fig. 52*e*) approximately 1½ times as long as wide, distal half of inner surface plumose; three plumose setae present on distal surface, single plumose seta on outer distal surface and 1 plumose setule on either side of setae.

Antennule (fig. 52*g*) 2-segmented, attached to lateral-anterior ventral surface of cephalothorax. First segment slightly less than twice the length of second, broader proximally than distally; ventrally curved distal half of anterior surface with approximately 18 plumose setules. Second segment rodlike, distal end with approximately 12 naked setules. Antenna (fig. 52*h*) 3-segmented, attached medial and posterior to antennule base. First segment squat, irregular, heavily sclerotized; second segment tapered slightly from broad proximal to slightly narrower distal end, proximal outer surface with small, subtriangular projection. Third segment and clawlike terminal process indistinctly separable, segment elongate, with small, lappet-like projection from posterior medial surface.

Mandible (fig. 52*h*) 4-parted, rodlike, distalmost part curved inward, with 12 denticulations on inner surface. Postantennal process

Figure 52.—*Caligus pelamydis* Krøyer, 1863, female: *a*, dorsal view (broken line=nick in specimen). Ventral view: *b*, posterior cephalothoracic sinus; *c*, genital segment (anterior end directed downward); *d*, fifth leg; *e*, caudal ramus; *f*, right side of frontal region showing lunule and antennule base; *g*, right antennule; *h*, oral region, left side showing antenna, postantennal process, mouth cone, mandible, maxillule, postoral process, and maxilla base; *i*, left maxilla; *j*, left maxilliped; *k*, sternal furca.


a
1.0 mm.
b
0.1 mm.
c
0.5 mm.
d
0.05 mm.
e
0.1 mm.
f
0.1 mm.
g
0.1 mm.
h
0.1 mm.
i
0.1 mm.
j
0.1 mm.
k
0.1 mm.

(fig. 52*h*) situated lateral and slightly posterior to antenna base, consisting of short, heavily sclerotized, dagger-shaped projection and 3 nodules, 2 at base of projection, third slightly posterior, each with several hairlike processes. Postoral process (fig. 52*h*) large, heavily sclerotized, spinelike. Maxillule (fig. 52*h*) nodular, situated adjacent to inner proximal surface of postoral process, with 3 setules distally. Maxilla (fig. 32*i*) 2-segmented, situated slightly lateral and posterior to postoral process. First segment approximately four-fifths the length of second, second elongate, with narrow, frilled membrane on medial inner surface, with 2 saber-shaped terminal processes. Innermost terminal process approximately 1½ times the length of outermost, both with fine membranes along inner and outer margins.

Maxilliped (fig. 52*j*) 2-segmented, situated medial and posterior to maxilla base. First segment strongly developed, with narrow, heavily sclerotized, strongly curved proximal articulation and muscle attachment surface. Second segment indistinctly separable from clawlike terminal process, with single, small, setule-like accessory process from distal inner surface. Sternal furca (fig. 52*k*) situated between and slightly posterior to maxilliped bases, tines broad, parallel, terminating in rounded surface. Furca associated with platelike area of heavy sclerotization extending posteriorly almost to interpodal plate of first thoracic legs and extending laterally past line running along longitudinal axis of body, through region of attachment of maxilliped bases.

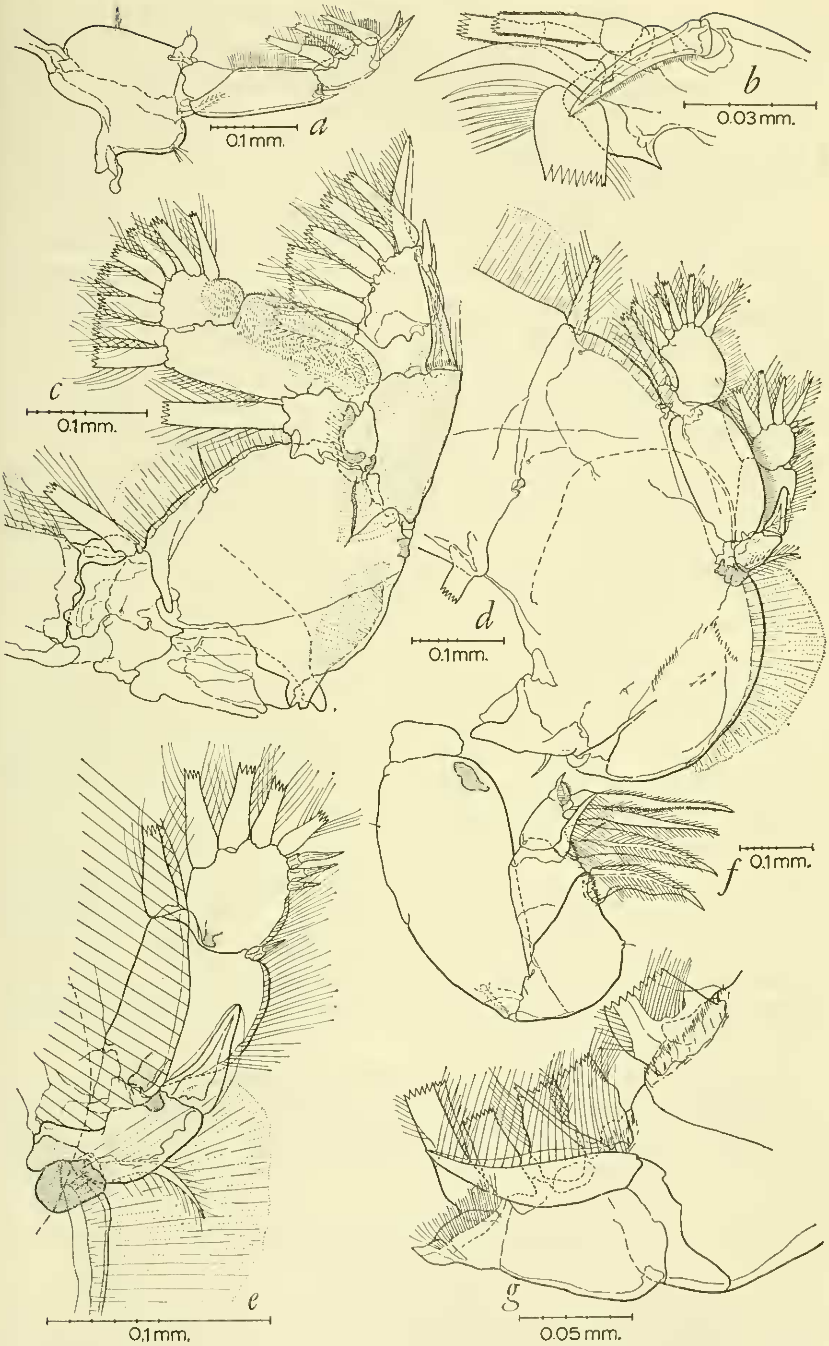
Fourth thoracic leg uniramous, poorly developed, similar, in segment constitution, to that of caligids in last chalimus stages. For nature of legs and armature, see figure 53 and table 19.

TABLE 19.—*Armature of thoracic legs I–IV of the female of* Caligus pelamydis *Krøyer, 1863*

Leg	Surface	Interpodal Plate	Protopodite 1	Protopodite 2	Exopodite 1	Exopodite 2	Exopodite 3	Endopodite 1	Endopodite 2	Endopodite 3
I	Outer		sss,p		h	4H		s		
	Inner		p		c	3P		s		
II	Outer	m		m	m,fm,H	H	H,mH,Q		C	C,3P
	Inner		s,P	m,s	c,P	c,P	5P	P	c,2P	3P
III	Outer	m	m,d,p		H	c,p′	c,3p′,P	c	c,2P	
	Inner		2s,P,s,m,s			P	3P	P	4P	
IV*	Outer		2s,p		s,fm,pH	fm,2pH,p′, 3pH,fm				

*Segmentation of this leg in doubt: protopodite and first segment of exopodite recognizable, others questionable.

FIGURE 53.—*Caligus pelamydis* Krøyer, 1863, female, right thoracic legs, anterior view: *a*, first; *b*, distal end of second segment of exopodite of first; *c*, second; *d*, third; *e*, exopodite of third; *f*, fourth; *g*, exopodite of fourth.


a
0.1 mm.
b
0.03 mm.
c
0.1 mm.
d
0.1 mm.
f
0.1 mm.
e
0.1 mm.
g
0.05 mm.

DISCUSSION.—Wilson (1905b) suggests that *Caligus pelamydis* Krøyer, and *C. scomberi* Bassett-Smith are synonymous but they were not synonymyzed until 1913 (Scott and Scott). Guiart (1913), however, feels that there is some evidence for maintaining both species. In comparing the two, he states: "Cette espèce [*C. pelamydis*] est beaucoup plus volumineuse que la précédente [*C. scombri*, T. Scott's (1901) modification of Bassett-Smith's *C. scomberi*], le segment génital beancoup (sic) plus long et l'abdomen nettement forme de deux segments. Beaucoup d'autres caractères s'opposent du reste à la fusion de cette espèce avec la précédente, comme le voulait Wilson (8, p. 596)." Scott and Scott (1913, p. 59), however, state: "We think there can be no reasonable doubt that the form obtained by Krøyer on *Pelamys sarda*, and described by him in the work referred to under the name of *Caligus pelamydis*, is identical with that from the mackerel [*C. scombri*]; the general structure of the animal, the shape of the sternal fork and of the genital segment, and the structure and armature of the fourth pair of thoracic legs, are similar in both forms." A comparison of specimens of these species in the U.S. National Museum suggests, to the present author, that the two are synonymous.

Caligus pelamydis is most readily distinguished by the nature of the fourth thoracic leg. The shape of the female genital segment is variable. In some of the specimens in the U.S. National Museum (USNM 74284 and 74358) the lobate condition of the posterior end of the genital segment is present, as shown in figures 52*a*,*c*, while in others the lobes are reduced or absent.

The fourth thoracic leg is complex, the armature elements are poorly defined, and, in most cases, lightly sclerotized. The figure given by Wilson (1905b, pl. 13: fig. 161) does not show the frilled membranes adjacent to the bases of at least the first 2 spines and does not show the fine accessory projection at base of the second spine that was evident in a stained mount of the leg made from a specimen in the USNM collection.

Caligus kanagurta Pillai, 1961, exhibits a very close similarity to *C. pelamydis*. The fourth thoracic leg, however, is figured as having three small, plumose spines on the distal segment which are not present in *C. pelamydis*.

Caligus longipedis Bassett-Simth

FIGURES 54–56

Caligus longipedis Bassett-Smith, 1898b, p. 359, pl. 10, figs. 2–3.—Yamaguti, 1963, p. 56.

Caligus longipes Bassett-Smith, 1899, p. 452.—Wilson, 1905b, p. 556 (in key).

Caligus amplifurcus Pearse, 1952b, p. 199, figs. 29–35.—Shiino, 1959d, p. 280, figs. 7–8.—Yamaguti, 1963, p. 49.
Caligus amplifurcatus Pearse, 1952b, p. 200 (figure title) (lapsus).
Caligus lucidus Heegaard, 1962, p. 158, figs. 54–61.

Distribution and hosts.—4 host records:

locality	*hosts*	*references*
Gulf of Aden	*Caranx melamphigus*	Bassett-Smith, 1898b
Australia	*Cantherhines ayraud*	Heegaard, 1962
Eastern Pacific	*Caranx lugubrius*	Shiino, 1959
Gulf of Mexico	*Caranx crysos*	Pearse, 1952b

Material.—Twenty-six females and 3 males (USNM 112915) from the external surface of *Caranx melampygus* Cuvier and Valenciennes, captured in fishtrap by Samuel Kaolulo between Diamond Head and Koko Head, Oahu, Hawaii. One female (USNM 112916) from the external surface of *C. melampygus* Cuvier and Valenciennes, captured in fishtrap by Samuel Kaolulo between Diamond Head and Koko Head, Oahu, Hawaii. Four females (one damaged) and 1 male (retained by author) from the external surface of *C. melampygus* Cuvier and Valenciennes, captured in fishtrap by Samuel Kaolulo between Diamond Head and Koko Head, Oahu, Hawaii.

Measurements.—(In mm) 28 females and 4 males:

	female		*male*	
	mean	*range*	*mean*	*range*
Total length, excluding caudal setae	5. 06	4. 58–5. 48	5. 24	5. 03–5. 48
Length of cephalothorax, including frontal region	3. 16	2. 89–3. 33	3. 47	3. 07–3. 74
Width of cephalothorax	2. 94	2. 63–3. 11	3. 32	3. 15–3. 52
Length of genital segment	1. 12	0. 94–1. 35	0. 78	0. 76–0. 83
Width of genital segment	1. 29	1. 00–1. 52	0. 83	0. 81–0. 89
Length of abdomen	0. 56	0. 49–0. 67	0. 60	0. 56–0. 63
Length of caudal rami	0. 29	0. 27–0. 33	0. 39	0. 38–0. 41
Length of egg strings (10 strings)	3. 24	2. 22–3. 96		

Description.—Female cephalothorax (fig. 54*b*) ovoid, consisting of cephalon and first 4 thoracic segments. Greatest length of frontal region approximately one-tenth that of entire cephalothorax, with fine membrane along anterior margin, bearing pair of ovoid lunules (fig. 55*a*) extending posteriorly, on ventral surface, to junction of frontal region and rest of cephalothorax. Lateral margin of cephalothorax slightly irregular, with narrow membrane extending laterally and second membrane extending medially, on ventral surface. Posterior-lateral dorsal surface of cephalothorax with small, posteriorly facing depression. Posterior sinus (fig. 54*c*) irregularly U-shaped, with thickened membrane-like projection along outer margin. Posterior median cephalothoracic surface projecting well past lateral surfaces, posterior end of surface with short, lappet-like projections laterally. Major dorsal cephalothoracic grooves incomplete, partially replaced by heavily sclerotized bands forming irregular H. Ocular region distinct, in anterior third of body.

Female free fourth pedigerous segment distinct from cephalothorax, incompletely separable from genital segment dorsally and ventrally,

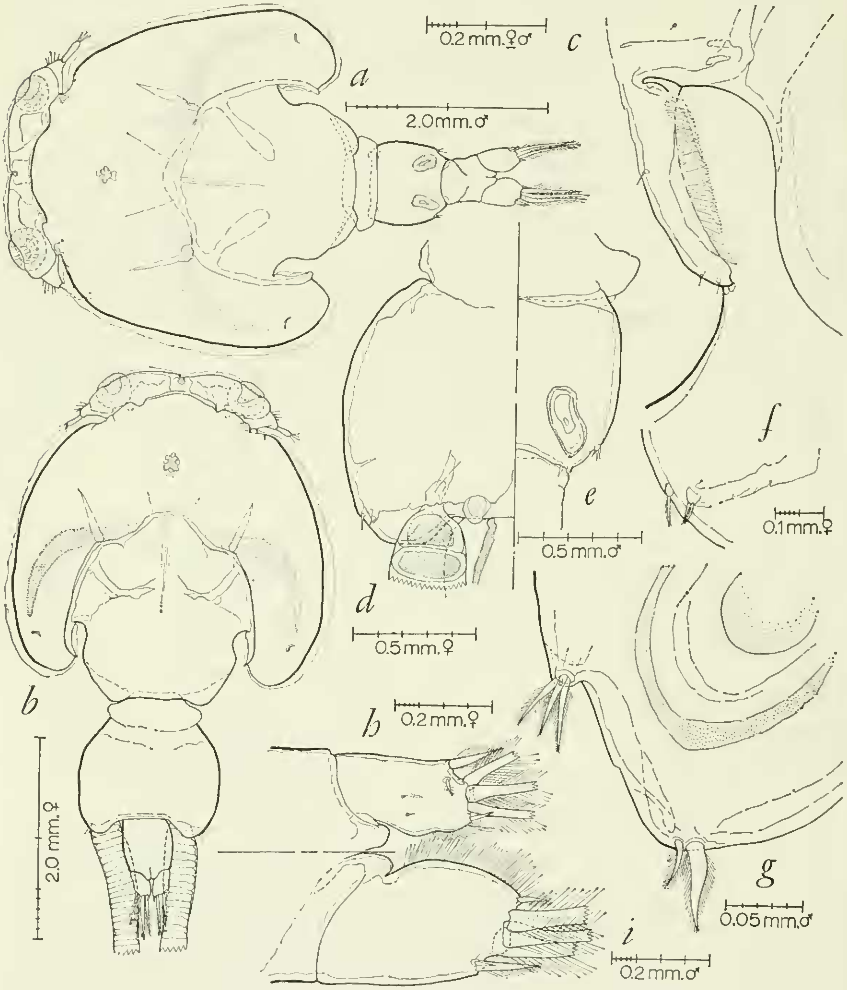


FIGURE 54.—*Caligus longipedis* Bassett-Smith, 1898, dorsal view: *a*, male; *b*, female; *c*; posterior cephalothoracic sinus. Ventral view: *d*, female genital segment; *e*, male, same, *f*, female fifth leg; *g*, male fifth and sixth legs; *h*, female caudal ramus; *i*, male, same.

overlapped anteriorly by lappet-like projections of posterior median cephalothoracic surface. Segment widest medially, angled toward anterior end, convexly curved posteriorly. Genital segment (fig. 54*d*) obcordate. Fifth legs (fig. 54*f*) situated on posterior lateral surface, consisting of 2 nodules, anteriormost with single plumose setule, posterior with 2 plumose setules. Abdomen 1-segmented, broadest anteriorly, constricted at anterior end, tapered to biconcave posterior end. Caudal rami (fig. 54*h*) subrectangular, with slight concavity on medial inner surface, inner surface plumose. Distal end of rami with 3 long, plumose setae medially, additional seta on outer distal surface, plumose setule on inner surface and second on ventral surface just proximal and medial to outermost seta.

Male cephalothorax (fig. 54*a*) similar to that of female, free fourth pedigerous segment slightly shorter, distinct from both cephalothorax and genital segment, with flat or slightly concave dorsal posterior margin instead of convex margin of female. Genital segment (fig. 54*e*) of general barrel shape, lateral surface indented posteriorly, at origin of fifth legs. Fifth legs (fig. 54*g*) consisting of nodule bearing 3 plumose setules; sixth legs (fig. 54*g*) situated on posterior-lateral ventral surface, consisting of 2 closely associated plumose setules. Abdomen 1-segmented although incomplete V-shaped band of heavy sclerotization in anterior portion giving 2-segmented appearance. Posterior region of abdomen widest, posterior surface biconcave, with distinct anal depression. Caudal rami (fig. 54*i*) larger than those of female, inner surface convex, plumose in distal half, remaining armature as in female.

Female and male antennule (fig. 55*b*) 2-segmented, attached to knoblike extension of ventral-lateral anterior surface of cephalothorax, not appearing to be attached to frontal region. First segment slightly more than twice the length of second (male second segment slightly longer), anterior margin bent almost at right angle medially, anterior and anterior ventral surface of distal half of segment bearing approximately 21 lightly plumose setae and setules. Second segment club shaped, distal end with approximately 12 naked setules. Female antenna (fig. 55*c*) 3-segmented, situated medial and posterior to antennule base. First segment short, squat, irregular, with spike-like projection from posterior distal surface. Second segment strongly developed, broad proximally, tapered to narrower distal end. Third segment fused with clawlike terminal process, bearing setule-like accessory process from proximal inner surface, second from anterior surface. Male antenna (fig. 55*d*) 3-segmented, first segment irregular, second irregularly club shaped, with indistinct adhesion surface on medial inner surface, with distinct swelling just distal to adhesion surface, swelling bearing well-defined adhesion surface. Third segment abrupt, terminal process fan shaped, with setule-like accessory process on distal inner surface.

Female and male mandible (fig. 55*c*) 4-parted, distalmost part curved inward, bearing 12 denticulations along inner surface. Female postantennal process (fig. 55*c*) situated lateral to antenna base, consisting of elongate, spine-shaped projection and 3 nodules, 2 on base of projection, third slightly posterior to base, each with several hairlike projections. Male postantennal process similar to that of female except spine-shaped projection longer. Female and male postoral process (fig. 55*c*) spine shaped, proximal end broad, medial region narrow, distal region expanded, flattened. Female and male maxillule (fig. 55*c*) consisting of pseudosegmented node bearing 3 setules distally. Female and male maxilla (figs. 55*e*, *f*) 2-segmented, situated slightly lateral and posterior to postoral process. Second segment approximately 1¼ times the length of first, both segments elongate, second thinner than first, distal end of outer surface knoblike, distal half of outer surface finely denticulated. Second segment bearing membranous conical process distally and 2 saber-shaped terminal processes, innermost slightly less than twice the length of outermost, with fine membrane along both margins; outermost terminal process with finely frilled membrane along both margins.

Female maxilliped (fig. 55*g*) 2-segmented, small in comparison with that of other members of the genus, situated medial and posterior to maxilla base. First segment well developed although of general elongate nature, tapered proximally to narrow proximal end. Second segment slender, approximately four-tenths the length of first, distinct from short, clawlike terminal process, bearing setule-like accessory process from distal inner surface (not figured) and small, hairlike process from nodule on distal posterior surface. Male maxilliped (fig. 55*h*) slightly larger than that of female, first segment more strongly developed, with 2 ridge-shaped projections on inner surface, distalmost with small secondary ridge bearing adhesion surface. Second segment and processes as in female. Female and male sternal furca (fig. 55*i*) situated between and posterior to maxilliped bases. Furcal base elongate, tines angled outward slightly, with broad surface, bluntly rounded distally.

Inner 2 terminal spines of second segment of exopodite of first thoracic leg bifid, both parts of equal length. For armature and nature of thoracic legs, see figure 56 and table 20.

Discussion.—One of the distinguishing characteristics of *C. longipedis* is the nature of the second segment of the maxilla, with its broad distal end, denticulated margin, and membranous, spine-shaped subterminal process. Additionally, the broad tines of the sternal furca and the long processes on the exopodite of the fourth thoracic leg are diagnostic characteristics. Although Bassett-Smith's original description (1898b) and figures leave much to be desired, these characteristics, as well as the body shape, are evident. An examination of the type material of *C. amplifurcus* Pearse (USNM 93710)

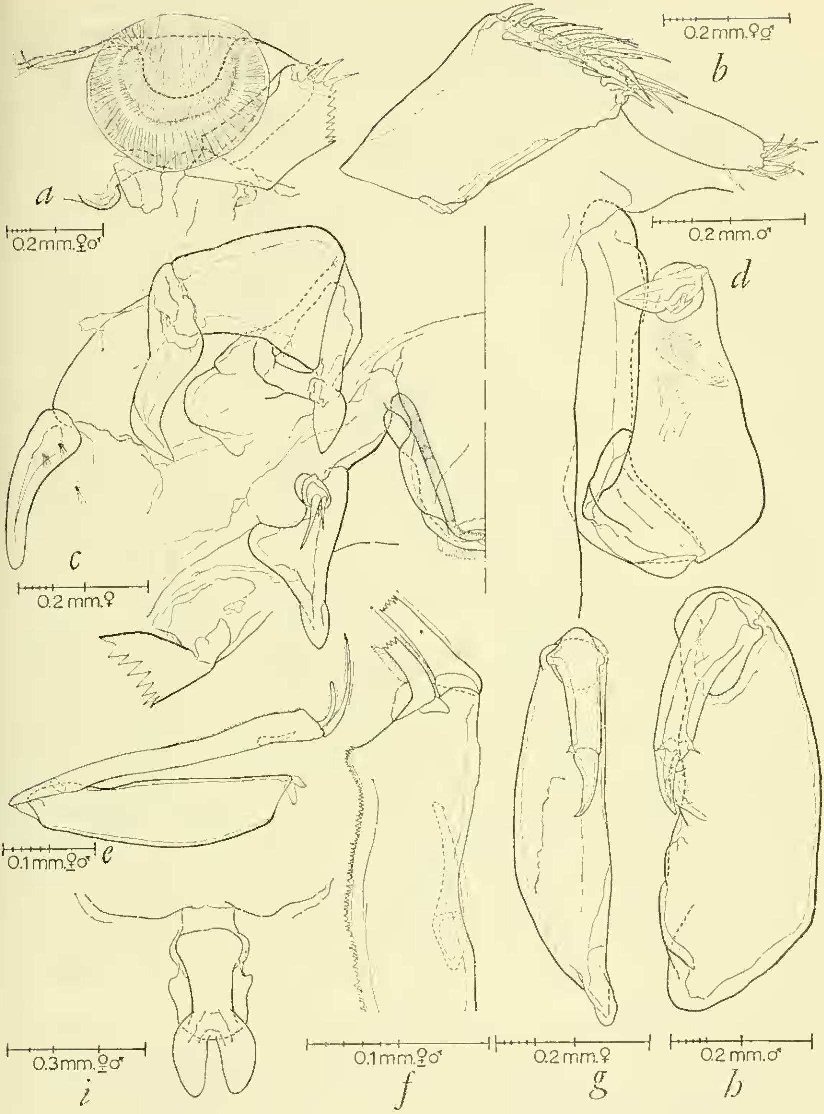


Figure 55.—*Caligus longipedis* Bassett-Smith, 1898, ventral view: *a*, frontal region, left side showing lunule and antennule base; *b*, left antennule; *c*, female oral region, right side showing antenna, postantennal process, mouth cone, mandible, maxillule, postoral process, and maxilla base; *d*, male right antenna; *e*, left maxilla; *f*, distal half of second segment of left maxilla; *g*, female right maxilliped; *h*, male, same; *i*, sternal furca.

TABLE 20.—*Armature of thoracic legs I–IV of the female and male of* Caligus longipedis *Bassett-Smith, 1898b*

Leg	Surface	Inter-podal Plate	Protopodite 1	Protopodite 2	Exopodite 1	Exopodite 2	Exopodite 3	Endopodite 1	Endopodite 2	Endopodite 3
I	Outer		s,p		rh	3H,P′				
	Inner		p		c,c	3P				
II	Outer	m		m,p*	m,fm,mH	mH	mh,mH,Q	c	c	c,2P
	Inner		s,P	m,s	c,P	c,P	5P	P	c,2P	4P
III	Outer	m	2s,m,p		m,s,H	c,2s,p′	c,3p′	c	c	
	Inner		2s,P,s,m,s			P	4P	P	6P	
IV	Outer		ss,s,P		dm,H	3dm,2H,mH				

*Plumosities not visible but minute fragments of dirt clustered around setule suggest fine plumosities are present.

showed the presence of these features as well as other characteristics of *C. longipedis*. In Pearse's original description (1952b), however, the figures do not indicate the relationship. The shape of the genital segment in the figure of the female, the presence of 2 segments in the abdomen of the figure of the male, and the "appendage on basal segment of second leg" (Pearse, 1952b, fig. 31) all suggest a species distinct from *C. longipedis*. Pearse, however, apparently made his description and figures from permanent whole mounts. The absence of spacers between the slide and the coverslip has distorted the shape of the body and, in one specimen at least, changed the shape of the appendages. The so-called appendage on the basal segment of the second leg could not be definitely found although, presumably in the original mounting of the specimens, the proximal end of one of the sclerites on the surface of the second segment of the female second thoracic leg has torn free. This sclerite projects anteriorly and medially, giving an appearance similar to that shown in Pearse's figure 31 and the appearance that it arises from the first segment of the protopodite.

Although the author has not examined specimens of *Caligus lucidus* Heegaard, 1962, the suggested nature of the maxilla (Heegaard's "first maxilliped," no figure number given but identified as MxP_1 in figure series 54–61), the nature of the armature on the fourth thoracic leg (fig. 58; although the segmentation is not shown), and the shape of the body of the female all indicate that the species is synonymous with *C. longipedis*.

The description by Shiino, 1959d, of *C. amplifurcus* Pearse differs in few details from that given here. The one important difference is that Shiino indicates the presence of 2 segments in the exopodite of the third thoracic leg while the present author indicates that this ramus is 3-segmented. As in *C. quadratus*, however, Shiino

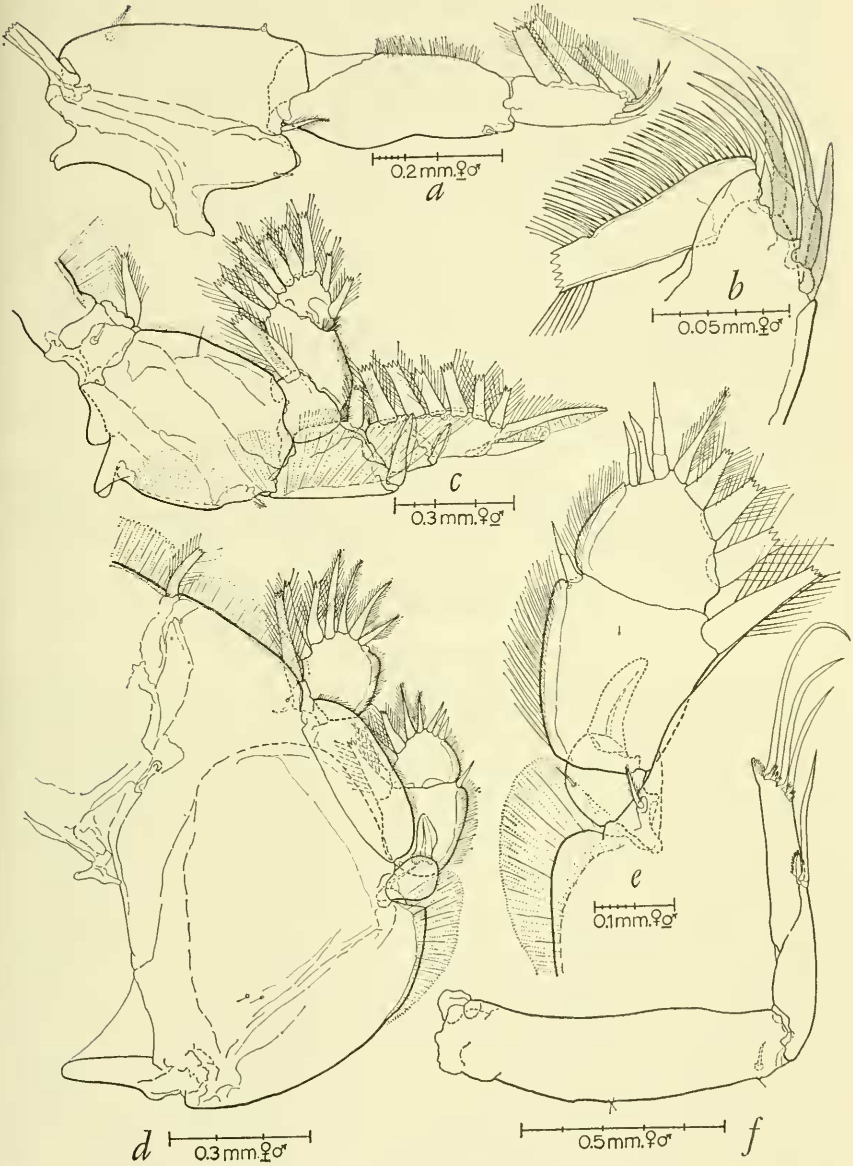


FIGURE 56.—*Caligus longipedis* Bassett-Smith, 1898, right thoracic legs, anterior view: *a*, first; *b*, distal region of second segment of exopodite of first; *c*, second; *d*, third; *e*, exopodite of third (posterior view); *f*, fourth.

indicates that the first segment includes not only the segment bearing the hook-shaped spine but also the succeeding segment and it is here suggested (fig. 56*e*) that these are 2 distinct segments.

The distribution of *C. longipedis* is intriguing. Originally described from near Aden, it has since been described from Australia, the Revillagigedos, the Gulf of Mexico, and now Hawaii. Peculiarly enough, there has, to the author's knowledge, never been a specimen described from either India or Ceylon. Many of the collections of parasitic copepods made from the latter, however, were from market fish, and in a good many cases these collections were from the gill cavities and buccal cavity of the hosts. The only reports giving parasite location of *C. longipedis* indicate that it is found on the external surface of the host. In collections from Hawaiian fishes it was noted that specimens of this species move rapidly and have a tendency to crawl off the surface of the host when it starts to dry.

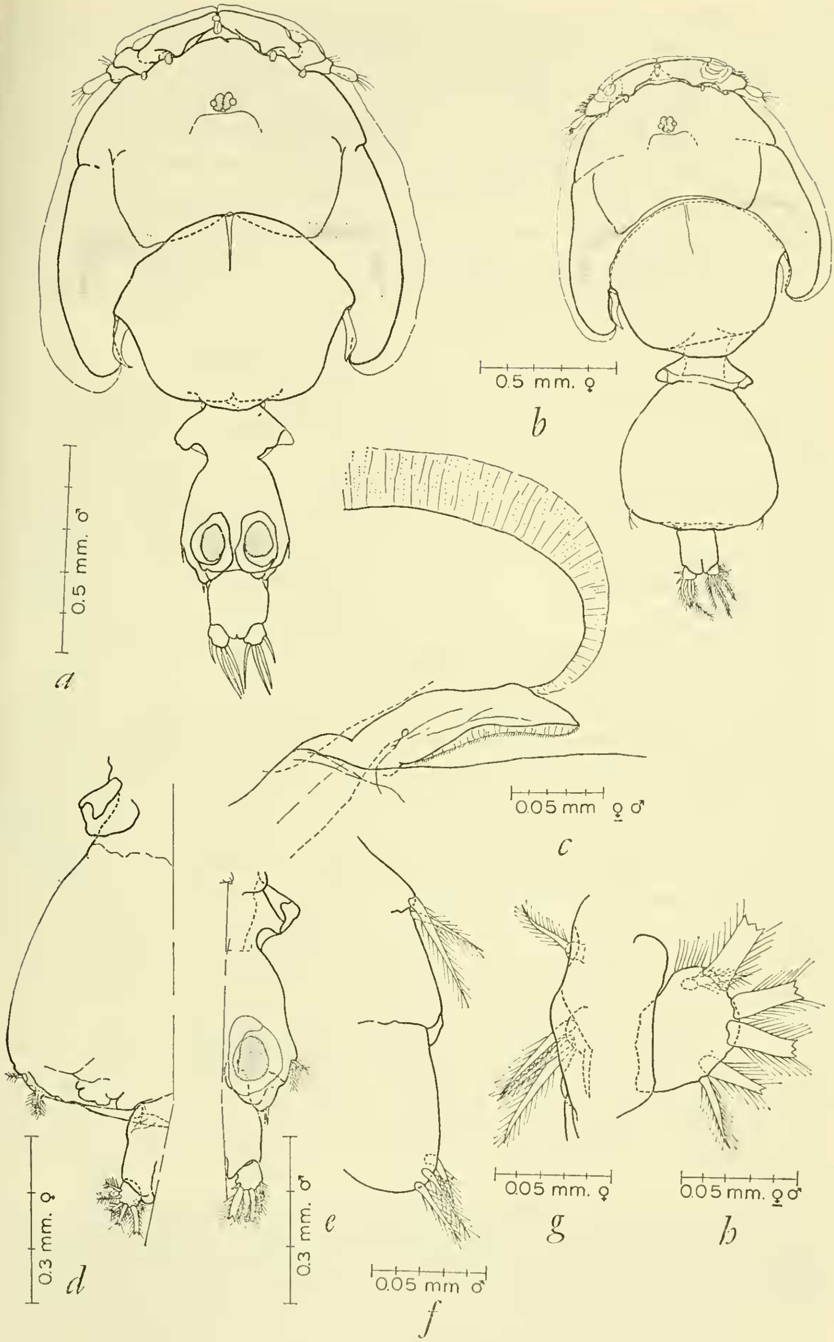
C. rugosus Shiino, 1959d, exhibits characteristics which closely ally it with *C. longipedis* (maxilla, thoracic legs). The exact relationship, however, can not be presently determined.

***Caligus kapuhili*, new species**

FIGURES 57–59

MATERIAL.—One female (holotype, USNM 112918) from the gill cavity of *Chaetodon miliaris* Quoy and Gaimard, captured in a fishtrap by Lester Zukeran in Kaneohe Bay, Oahu, Hawaii. One male (allotype, USNM 112919) from the holotype host specimen. One female and 1 male (paratypes, USNM 112920) from the gill cavity of *C. miliaris* Q. and G., captured in a fishtrap by Lester Zukeran in Kaneohe Bay, Oahu, Hawaii. Two females and 1 male (paratypes, USNM 112921) from the gill cavity of an unknown chaetodontid captured in the Oahu area, Hawaii. One female (paratype, USNM 112922) from the gill cavity of *Chaetodon fremblii* Bennett, speared by Carolyn Lewis off Rabbit Island, Oahu, Hawaii. One female (paratype, USNM 112923) from the gill cavity of *C. miliaris* Q. and G. from the Honolulu Aquarium. One female (paratype, USNM 112924) from the gill cavity of *C. miliaris* Q. and G., captured in a fishtrap by Lester Zukeran in Kaneohe Bay, Oahu, Hawaii. One female (paratype, USNM 112925) from the gill cavity of *C. miliaris* Q. and G., captured in a fishtrap by Lester Zukeran in Kanohe Bay, Oahu, Hawaii. Five females and 2 males (one immature) (paratypes,

FIGURE 57.—*Caligus kapuhili*, new species, dorsal view: *a*, male; *b*, female; *c*, posterior cephalothoracic sinus. Ventral view: *d*, female free fourth pedigerous segment, genital segment, abdomen, and caudal ramus; *e*, male, same; *f*, male fifth and sixth legs; *g*, female fifth leg; *h*, caudal ramus



0.5 mm. ♂
a
0.5 mm. ♀
b
0.05 mm ♀♂
c
0.3 mm. ♀
d
0.3 mm. ♂
e
0.05 mm ♂
f
0.05 mm. ♀
g
0.05 mm. ♀♂
h

USNM 112926) from the gill cavity of several specimens of *C. fremblii* Bennett, captured in fishtraps by Samuel Kaolulo between Diamond Head and Koko Head, Oahu, Hawaii. One female and 1 male (male damaged) (paratypes, retained by author) from the gill cavity of *C. fremblii* Bennett, speared by Carolyn Lewis off Rabbit Island, Oahu, Hawaii. Two females (1 damaged) (paratypes, retained by author) from the gill cavity of *C. miliaris* Q. and G., captured in a fishtrap by Lester Zukeran in Kaneohe Bay, Oahu, Hawaii. Four females and 2 males (1 male damaged) (paratypes, retained by author) from the gill cavity of 4 specimens of *C. miliaris* Q. and G., captured in fishtraps by Lester Zukeran in Kaneohe Bay, Oahu, Hawaii.

Measurements.—(In mm) 17 females and 5 males:

	female		*male*	
	mean	*range*	*mean*	*range*
Total length, excluding caudal setae	1. 94	1. 67–2. 37	1. 52	1. 44–1. 59
Length of cephalothorax, including frontal region	1. 03	0. 92–1. 10	0. 90	0. 86–0. 92
Width of cephalothorax	0. 91	0. 79–1. 01	0. 78	0. 76–0. 85
Length of genital segment	0. 57	0. 45–0. 72	0. 32	0. 32–0. 34
Width of genital segment	0. 63	0. 50–0. 74	0. 26	0. 25–0. 27
Length of abdomen	0. 19	0. 13–0. 23	0. 14	0. 14–0. 15
Length of caudal rami	0. 06	0. 05–0. 07	0. 05	(all)
Length of egg strings (3 strings) 0. 74, 0. 56, 0. 72				

Description.—Female cephalothorax (fig. 57*b*) ovoid, consisting of cephalon and first 4 thoracic segments. Frontal region distinct, approximately one-twelfth the total length of cephalothorax, with fine membrane along anterior margin. Lunules (fig. 58*a*) large though finely membranous, extending posteriorly, on ventral surface, almost to junction of frontal region and remaining cephalothorax. Lateral margins of cephalothorax smooth, slightly irregular, with slight indentation in anterior third, with fine membrane extending laterally. Posterior sinus (fig. 57*c*) narrow, irregularly V-shaped, with finely frilled membrane on outer margin. Posterior median cephalothoracic region projecting well past posterior lateral regions, with broad, lappet-like projection extending from posterior surface over anterior end of free fourth pedigerous segment. Major dorsal cephalothoracic grooves forming irregular H, posterior legs and crossbar of H continuous. Ocular region distinct, in anterior third of cephalothorax.

Female free fourth pedigerous segment distinctly separable from cephalothorax, indistinctly separable from genital segment; segment angled sharply toward anterior end from region of fourth leg attachment, in posterior part of segment. Genital segment (fig. 57*d*) subtriangular, distended by eggs in figured female, posterior surface overlapping anterior end of abdomen dorsally. Fifth legs (fig. 57*g*)

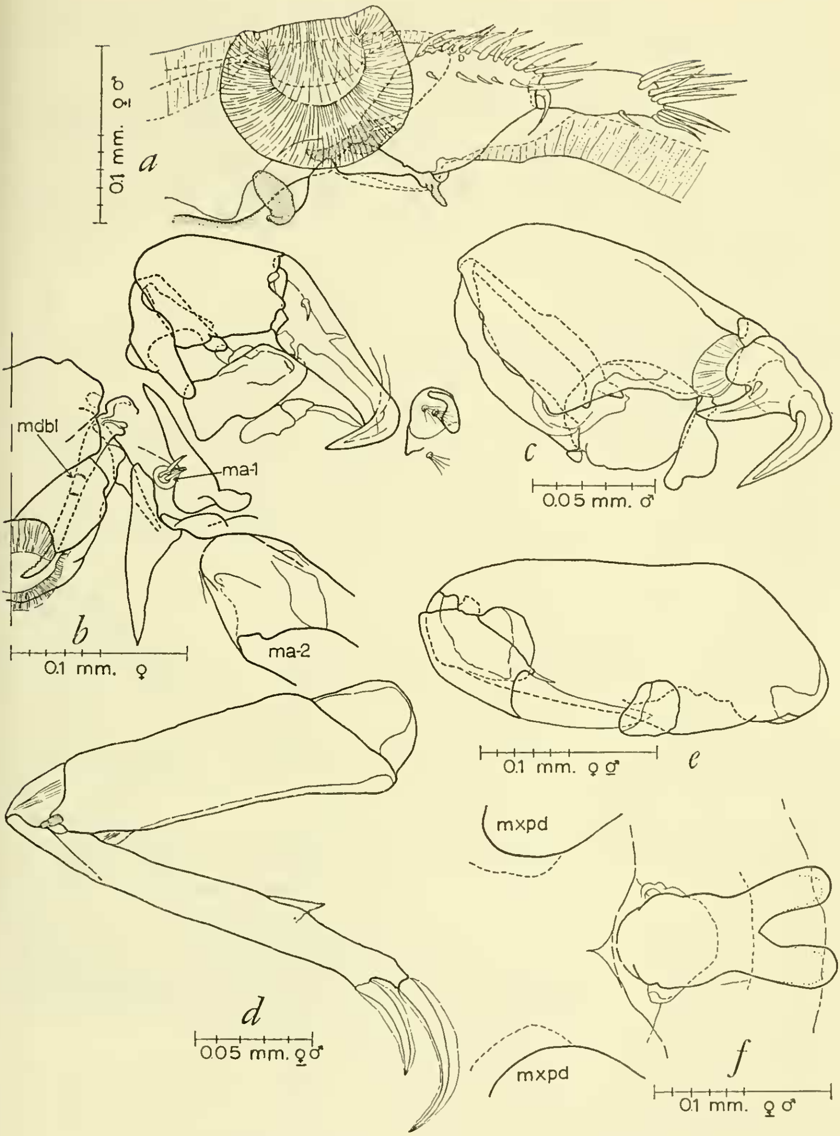


FIGURE 58.—*Caligus kapuhili*, new species, ventral view: *a*, left antennule and frontal region showing lunule; *b*, female oral region, left side showing antenna, postantennal process, mouth cone, mandible (mdbl), maxillule (ma-1), postoral process, and maxilla base (ma-2); *c*, male left antenna; *d*, right maxilla; *e*, left maxilliped; *f*, sternal furca and maxilliped bases (mxpd).

situated on posterior lateral surface of genital segment, consisting of 2 nodules, each in slight depression; anteriormost nodule with single plumose setule, posterior with 3 plumose setules.

Abdomen 1-segmented, distinct from genital segment, anterior half slightly swollen, posterior half straight, anal identation in medial posterior surface formed by pair of small, lappet-like projections. Caudal rami (fig. 57*h*) short, rounded distal half of inner margin plumose, distal surface with 4 plumose setae and 2 plumose setules, 1 on either side of setae.

Male cephalothorax (fig. 57*a*) similar to that of female. Free fourth pedigerous segment distinct from cephalothorax, fused with genital segment, shape as in female. Genital segment (fig. 57*e*) narrow anteriorly, broader posteriorly, with slight indentation at fifth leg and with small, lobate projections from posterior ventral surface. Fifth legs (fig. 57*f*) consisting of 2 plumose setules; sixth legs (fig.57*f*) arising from 1 of lobate projections on posterior ventral surface of genital segment, consisting of 3 plumose setules. Abdomen and caudal rami similar to those of female although anterior end of abdomen not swollen as in female.

Female and male antennule (fig. 58*a*) 2-segmented, attached to lateral-anterior ventral surface of cephalothorax and adjacent frontal region. First segment approximately 1½ times the length of second, narrow proximally and distally, broad medially, distal half of anterior and anterior ventral surface with approximately 21 lightly plumose setules. Second segment rodlike, with 12 naked setules distally. Female antenna (fig. 58*b*) 3-segmented, situated posterior and medial to antennule base. First segment socket-like, irregular; second segment broader proximally than distally. Third segment fused with clawlike terminal process, bearing setule-like accessory process proximally. Male antenna (fig. 58*c*) with similar first segment, second segment larger; third segment indistinctly separable from double-clawed terminal process, with setule-like accessory process at base of proximalmost claw, at junction of segment and terminal process.

Female and male mandible (fig. 58*b*) 4-parted, distalmost part flattened, with 12 denticulations along inner surface. Female and male postantennal process (fig. 58*b*) consisting of small, lappet-like projection and 3 nodules, 2 at base of projection, third slightly posterior to base, each with several hairlike processes. Female and male postoral process (fig. 58*b*) elongate, spinelike. Female and male maxillule (fig. 58*b*) nodular, with 3 setules distally. Female and male maxilla (fig. 58*d*) 2-segmented, situated lateral to postoral process. Both segments elongate, second more slender, slightly longer than first, with membranous projection from middle of inner surface and 2 saber-shaped terminal

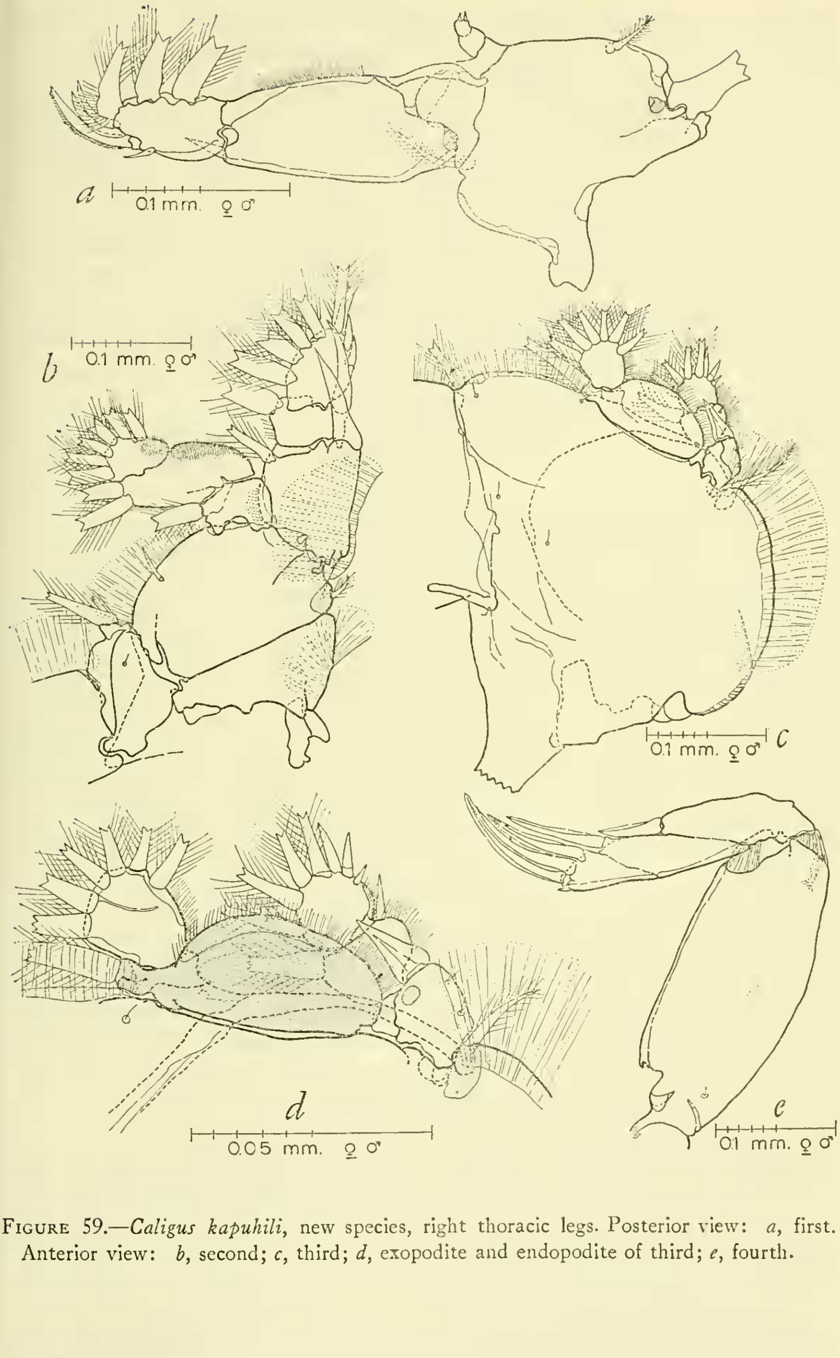


FIGURE 59.—*Caligus kapuhili*, new species, right thoracic legs. Posterior view: *a*, first. Anterior view: *b*, second; *c*, third; *d*, exopodite and endopodite of third; *e*, fourth.

processes. Innermost terminal process approximately 1½ times the length of outermost, both with fine membranes along margins.

Female and male maxilliped (fig. 58*e*) 2-segmented, situated posterior and slightly medial to base of maxilla. First segment strongly developed, with distally concave ledge on inner surface that receives tip of terminal process of second segment when segment flexed. Second segment distinct from clawlike terminal process, with single, setulelike accessory process on distal inner surface. Female and male sternal furca (fig. 58*f*) situated approximately halfway between maxilliped bases and interpodal plate of first thoracic legs, on small, heavily sclerotized platelike region projecting laterally as 2 small lobate processes, adjacent to base of furca. Furcal tines diverging, sinus irregularly V-shaped, tines broad, flat.

Spine at distal end of first segment of exopodite of third thoracic leg straight, not curved. For nature and armature of legs, see figure 59 and table 21.

TABLE 21.—*Armature of thoracic legs I–IV of the female and male of* Caligus kapuhili, *new species*

Leg	Surface	Interpodal Plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer		p		h	h,mH,2H			rh?	
	Inner		p		c	3P			rh?	
II	Outer	m		m,p	m,H	H	2h,Q		C	C, 3P
	Inner		P,s	m,s	c,P	c,P	5P	P	c,2P	3P
III	Outer	m	a,m,P		2ss,H	c,p′	c,3p′	c	c,3P	
	Inner		3s,P,m,s			P	4P	P	c,3P	
IV*	Outer		3s,p		mH	mh	3mH,m			

*Division between second and third segments of exopodite indistinct, incomplete.

DISCUSSION.—*Caligus kapuhili* exhibits several characteristics closely approximating those of *C. laticaudus* Shiino, 1960a. The similarity of the lunule, the female and male antenna (male *C. laticaudus* decribed by Pillai, 1961), the maxilliped with its cup-shaped projection on the first segment, and the similarity of the first 3 thoracic legs suggest that these 2 species are closely related. The differences between the species are in the body shape, the size relationship of the body parts, and the characteristics of the appendages other than those mentioned above. Shiino's female and only specimen of *C. laticaudus* is reportedly 3.51 mm in length. Pillai reports a length of 2.6 mm for his female specimens (no length given for the male), the average length of the Hawaiian female specimens is 1.94mm, and the range is from 1.67–2.37mm. The abdomen is distinctly 2-segmented in *C. laticaudus* and 1-segmented in *C. kapuhili*, while its length (female only) is 0.71mm in *C. laticaudus* and an average of 0.19 mm (range 0.13-0.23 mm) in *C. kapuhili.* The relationship of the length of the abdomen to the length of the body (average total length divided by average length of abdomen) is 4.94 in *C. laticaudus* and 10.2 in *C. kapuhili.* The spinelike projection of the postantennal process in *C. laticaudus* is elongate and distally pointed, while in *C. kapuhili* it is short and distally rounded. The fourth thoracic leg of *C. laticaudus* has a frilled membrane at the base of each spine; with the exception of the innermost terminal spine, these membranes are absent in *C. kapuhili.*

The species name is derived from "Kapuhili," the Hawaiian name for several of the chaetodontids or butterfly fishes, the host of the species.

Caligus kala Lewis

Figures 60, 61

Caligus kala Lewis, 1964a, p. 142, figs. 2–3

Distribution and hosts.—Hawaiian Islands, *Naso hexacanthus.*

Material.—One female and 1 male (USNM 112927) from the buccal cavity of *Dascyllus albisella* Gill, captured by spear by Robert Stevenson, Oahu, Hawaii. One male (USNM 112928) from the buccal cavity of *D. albisella* Gill from the Honolulu Aquarium. One immature male (USNM 112929) from the gill cavity of *Saurida gracilis* (Quoy and Gaimard), captured in a fishtrap by Samuel Kaolulo between Diamond Head and Koko Head, Oahu, Hawaii. Two males (USNM 112930) from the gill cavity of *D. albisella* Gill, captured by rotenone off Waikiki, Oahu by William Gosline. One female (USNM 112931) from the gill cavity of *D. albisella* Gill, from the Honolulu Aquarium. One immature male (USNM 112932) from the buccal cavity of *D. albisella* Gill, from the Honolulu Aquarium. One female and 1 male (retained by author) from the buccal cavity of *Pomacentrus jenkinsi* (Jordan and Evermann), speared by N. Ferris in Hanauma Bay, Oahu, Hawaii. One damaged female (retained by author) from the gill cavity of *D. albisella* Gill, from the Honolulu Aquarium.

Measurements.—(In mm) 5 females and 7 males:

	female		male	
	mean	range	mean	range
Total length, excluding caudal setae	4. 20	3. 95–4. 40	2. 79	2. 20–3. 20
Length of cephalothorax, including frontal region	2. 27	2. 10–2. 43	1. 87	1. 70–2. 05
Width of cephalothorax	1. 85	1. 75–2. 00	1. 50	1. 30–1. 63
Length of genital segment	1. 27	1. 18–1. 38	0. 53	0. 50–0. 60
Width of genital segment	1. 18	1. 00–1. 45	0. 63	0. 58–0. 78
Length of abdomen	0. 68	0. 61–0. 77	0. 31	0. 25–0. 37
Length of caudal rami	0. 14	0. 13–0. 15	0. 12	0. 10–0. 14
Length of egg strings (2 strings)	1. 30, 1. 48			

Description.—Female and male cephalothorax (figs. 60*a,b*) elliptical, consisting of cephalon and first 4 thoracic segments. Frontal region less than one-ninth the length of cephalothorax, with fine membrane along anterior margin. Lunules large, extending posteriorly, on ventral surface, slightly past division between frontal region and rest of cephalothorax. Posterior margin of median cephalothoracic region trilobed, not convex as originally described, median lobe projecting over anterior end of free fourth pedigerous segment. For description of rest of cephalothorax and fourth pedigerous segment, see original description.

Female genital segment (fig. 60*d*) of general obcordate shape although anterior end broadly rounded. Posterior lobes projecting to middle of abdomen, tipped by fifth legs. Fifth legs (fig. 60*f*) consisting of 2 knobs, outermost with single plumose setule, inner with 2 plumose setules. Female abdomen indistinctly 2-segmented, broad, lateral margins irregularly convex. First "segment" shorter than second, second with flatly angled distal end, with deep anal depression. Caudal rami of female and male (fig. 60*h*) as origionally described except for additional small setule present on outer distal ventral surface and hairlike process from middorsal surface.

Male genital segment (fig. 60*e*) of varible shape, variation appearing due to longitudinal contraction of free body segments. Distinct separation of fourth pedigerous and genital segments in holotype specimen, separation not visible in presently figured specimen but present in specimens exhibiting contracted condition. "Posterior margin" of original description (p. 144) thus formed by cuticular fold. Sixth leg (fig. 60*g*) present as small, naked setule and small plumose setule, both situated immediately ventral to junction of abdomen and genital segment.

In the description of the appendages and processes given below, those of the heretofore undescribed female are given only if they differ from the male. Additional descriptions are given if there appeared to be some error in the original description (Lewis, 1964a).

Female and male antennule (fig. 61*a*) as originally described except attachment to both frontal region and anterior-lateral ventral surface of cephalothorax, not just to frontal region. Female antenna (fig. 61*b*) 3-segmented, situated posterior and medial to antennule base. First segment short, squat, with posteriorly directed lobate projection; second segment broader proximally than distally, well developed. Third segment indistinctly separable from clawlike terminal process, with setule-like accessory process from proximal inner surface, second from inner distal surface. Male antenna (fig. 61*a*) as originally described except only one accessory process, on anterior inner surface. Female postantennal process (fig. 61*b*) situated lateral to antenna base,

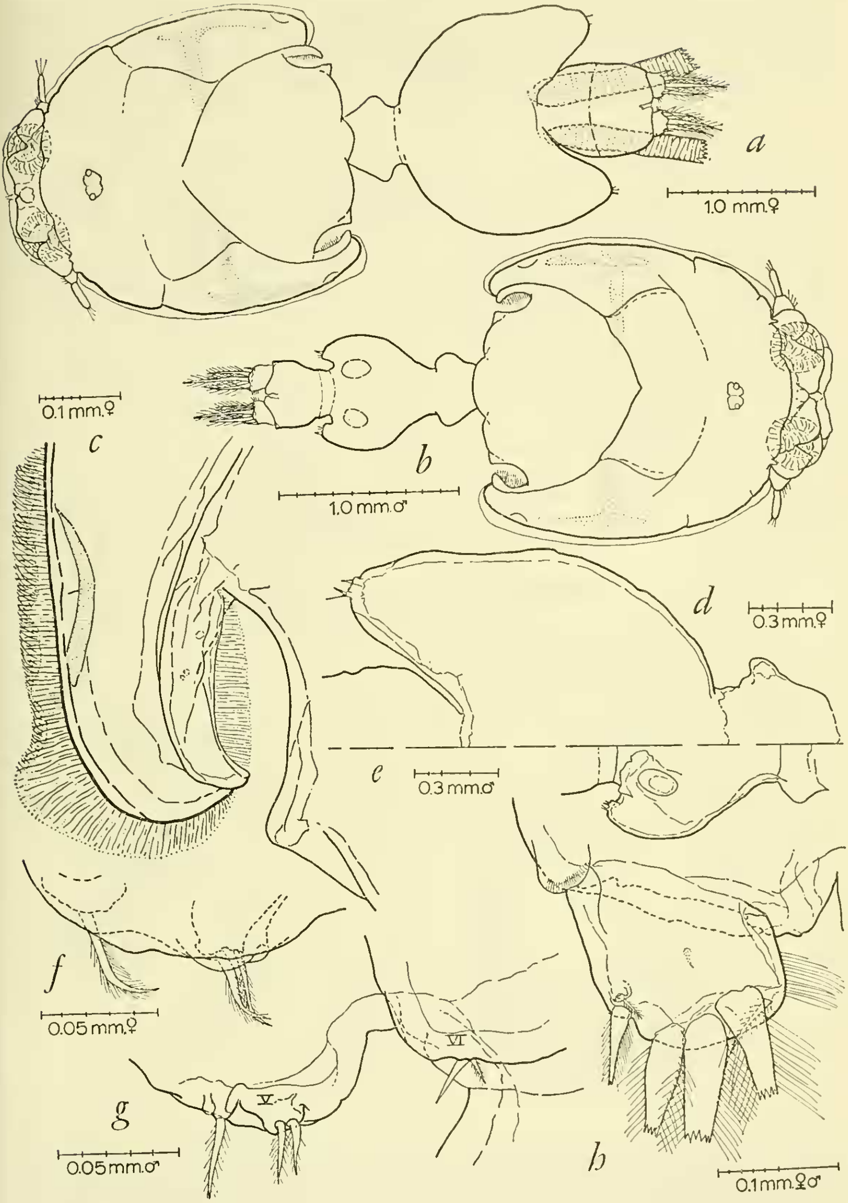


FIGURE 60.—*Caligus kala* Lewis, 1964, dorsal view: *a*, female; *b*, male; *c*, posterior cephalothoracic sinus. Ventral view: *d*, female genital segment; *e*, male, same; *f*, female right fifth leg; *g*, male right fifth (V) and sixth (VI) legs; *h*, caudal ramus.

consisting of short, slightly curved, spinelike process, with 2 nodes proximally, third node present slightly posterior to spinelike process, all 3 nodes with several hairlike processes. Male postantennal

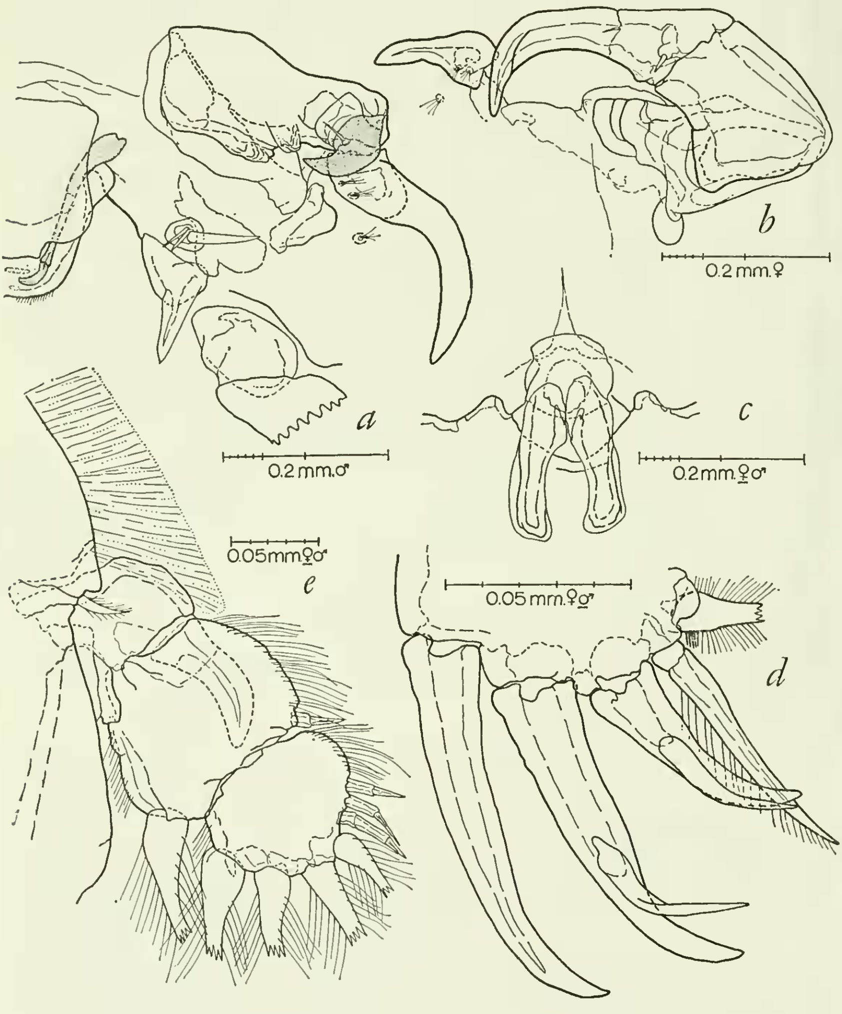


FIGURE 61.—*Caligus kala* Lewis, 1964, ventral view: *a*, male oral region, left side showing antenna, postantennal process, mouth cone, maxillule, postoral process, and maxilla base; *b*, female right antenna and postantennal process; *c*, sternal furca. Right thoracic legs: *d*, distal end of second segment of exopodite of first, anterior view; *e*, exopodite of third, posterior view.

process (fig. 61*a*) similar although spinelike process much longer than in female. Female and male maxillule (fig. 61*a*;=part of postoral process in original description) nodular, with 1 large and 2 small, setules. Female and male maxilla as originally described except lobate process on middle of second segment a folded membrane. Female maxilliped similar to that of male except with single tuberculate projection from middle of inner margin of first segment, not with 2 as in male.

Female and male sternal furca (fig. 61*c*) attached to ventral surface of cephalothorax between pair of small, lobate, anteriorly directed projections. Additional pair of somewhat larger lobate projections present between interpodal plates of first and second thoracic legs. First thoracic leg with distinct break in plumosities along inner surface of first segment of exopodite; both inner spines on distal surface of second segment of exopodite with flexible accessory processes, not just middle spine as originally indicated. Exopodite of third thoracic legs 3-segmented, not 2 as originally noted, protopodite with plumose setule at base of exopodite. Endopodite of third legs includes lobate projection previously indicated as arising between rami. For nature of armature and thoracic legs, see figures 61*d*, *e* and table 22 in present publication, figures 3*a-f* in Lewis, 1964a.

TABLE 22.—*Armature of thoracic legs I–IV of the female and male of* Caligus kala *Lewis, 1964a*

Leg	Surface	Inter-podal plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer		sss,P		rh	3H,P				
	Inner		d,p		c,c	3P				
II	Outer	m		m,p	m,m,mH	mH	h,H,Q,P	c,C	D	3P
	Inner		s,P	m,s	c,P	c,P	c,4P	P	P	c,3P
III	Outer	m	d,m,p		H	c,p′	c,3p′,P	c	c,3P	
	Inner		d,2s,P,s, m,s			c,P	c,3P	P	c,3P	
IV	Outer		2s,p		s,m,mH	4m,4mH				

Caligus ligatus Lewis

FIGURES 62–64

Caligus ligatus Lewis, 1964a, p. 164, figs. 8–9.

DISTRIBUTION AND HOSTS.—Hawaiian Islands, *Acanthurus dussumieri*, *Naso hexacanthus*.

MATERIAL.—Five females and 2 males (USNM 112933) from the gill cavity and buccal cavity of *Dascyllus albisella* Gill, from the Honolulu Aquarium. One male (retained by author) from the buccal cavity of *Aulostomus chinensis* (Linnaeus), captured in fishtrap by Samuel Kaolulo between Diamond Head and Koko Head, Oahu, Hawaii. One male (retained by author) from the gill cavity of

Holocentrus xantherythrus Jordan and Evermann, from the Honolulu Aquarium. One immature female and 5 males (retained by author) found in bait well after loading *Pranesus insularum* (Jordan and Evermann) at French Frigate Shoals (USFWS, JRM 31).

MEASUREMENTS.—(In mm) 5 females and 3 males:

	female		*male*
	mean	*range*	
Total length, excluding caudal setae	3. 29	3. 20–3. 35	2. 25, 2. 55, 2. 65
Length of cephalothorax, including frontal region	1. 62	1. 55–1. 68	1. 40, 1. 58, 1. 60
Width of cephalothorax	1. 49	1. 43–1. 53	1. 18, 1. 30, 1. 33
Length of genital segment	0. 95	0. 93–0. 98	0. 43, 0. 50, 0. 53
Width of genital segment	0. 93	0. 88–1. 03	0. 38, 0. 40, 0. 43
Length of abdomen	0. 59	0. 58–0. 61	0. 29, 0. 43, 0. 34
Length of caudal rami	0. 13	(all)	0. 12, 0. 15, 0. 14
Length of egg strings (2 strings)	1. 55, 0. 73		

DESCRIPTION.—Female cephalothorax (fig. 62*a*) ovoid, consisting of cephalon and first 4 thoracic segments. Frontal region approximately 15 percent of total length of cephalothorax, with broad membrane along anterior margin and pair of lunules (fig. 63*a*) extending posteriorly, on ventral surface, slightly past junction of frontal region and rest of cephalothorax. Lateral margin of cephalothorax slightly irregular, with fine membrane extending laterally and second membrane extending medially, on ventral surface; posterior lateral surface with small but distinct concavity. Posterior sinus (fig. 62*c*) irregularly U-shaped, with fine membrane along outer surface. Posterior median cephalothoracic region flatly convex, extending posteriorly well past lateral cephalothoracic regions, connected to free fourth pedigerous segment by flaccid arthrodial membrane. Major dorsal cephalothoracic grooves forming irregular H although anterior longitudinal grooves of H extending posteriorly and medially, past cross groove (more pronounced in female than in male). Ocular region distinct, in anterior third of cephalothorax.

Female free fourth pedigerous segment narrow anteriorly, lateral margins angled outward sharply to region of fourth leg attachment. Segment indistinctly separable from genital segment. Genital segment (fig. 62*d*) apple shaped, broader posteriorly, with fifth legs from ventral-posterior lateral surface. Fifth legs (fig. 62*f*) consisting of 2 knobs, anteriormost with 1 plumose setule, posteriormost with 2.

Female abdomen indistinctly separable from genital segment, consisting of 1 or 2 segments. Indication of segment division indistinctly present in middle of abdomen. Abdomen subrectangular, width approximately half the length, tapered slightly toward posterior end. Posterior end angled sharply at attachment of caudal rami, anal region bilobed. Caudal rami (fig. 62*h*) subrectangular, with small indentation on medial outer surface, indentation bearing single plumose seta. Three plumose setae present on distal surface; single plumose setule on inner distal surface, second on outer surface, just medial to indenta-

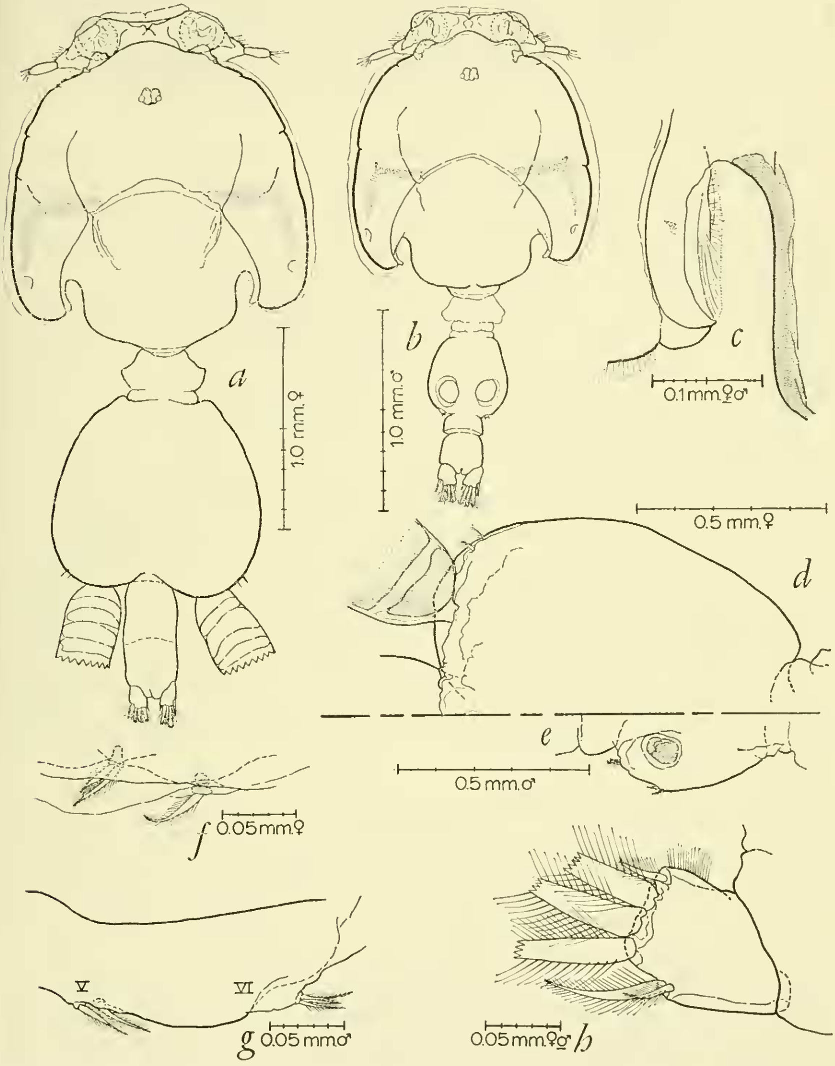


FIGURE 62.—*Caligus ligatus* Lewis, 1964, dorsal view: *a*, female; *b*, male; *c*, posterior cephalothoracic simus. Ventral view: *d*, female genital segment; *e*, male, same; *f*, female left fifth leg; *g*, male right fifth (V) and sixth (VI) legs; *h*, caudal ramus.

tion; distal half of inner surface plumose.

Male cephalothoax (fig. 62*b*) similar to that of female, free fourth pedigerous segment also similar except for irregular posterior lateral margins. Genital segment (fig. 62*e*) subovoid, fifth legs (fig. 62*g*) arising from ventral lateral surface, consisting of 2 knobs, each with single, plumose setule; sixth legs (fig. 62*g*) arising from slight swelling on lateral-posterior ventral surface, consisting of minute nodule bearing 3 plumose setules. Abdomen distinctly 2-segmented, first segment approximately one-third the total length, constricted sharply posteriorly; second segment slightly wider posteriorly than anteriorly. Caudal rami as in female.

Female and male antennule (fig. 63*b*) 2-segmented, attached to anterior ventral surface of cephalothorax, not attached to adjacent frontal region. First segment slightly less than 1½ times the length of second, narrow proximally and distally, broad medially; distal half of anterior and anterior ventral surface with approximately 23 plumose setae and setules. Second segment club shaped, with single naked setule from distal half of posterior surface, approximately 11 naked setules from distal surface. Female antenna (fig. 63*c*) 3-segmented, situated posterior and medial to antennule base. First segment dactyliform, ventrally facing surface irregular; second segment broader proximally than distally. Third segment short, incompletely fused to clawlike terminal process, with single setule-like accessory process from posterior medial surface. Male antenna (fig. 63*d*) 3-segmented, first segment elongate, irregular; second segment broader proximally than distally, with adhesion surface on proximal half of anterior surface and small, shelflike adhesion surface projecting from distal half. Third segment short, incompletely fused with short, bifurcate terminal process, tines of bifurcation sharply pointed. Single, setule-like accessory process present on distal anterior surface of segment.

Female and male mandible (fig. 63*c*) 4-parted, distalmost part curved medially, with 12 denticulations. Postantennal process of female (fig. 63*c*) situated lateral and slightly posterior to antenna base, consisting of short, clawlike projection with 3 associated nodules, 2 on base of projection, third just posterior to base, each with several hairlike processes. Male postantennal process (fig. 63*d*) consisting of long, strongly curved, clawlike projection with 2 nodules proximally, each with several hairlike processes, third nodule not visible. Female and male postoral process (fig. 63*c*) with broad base, tapered abruptly to slender, slightly curved spinelike projection. Female and male maxillule (fig. 63*c*) nodular, with 2 small and 1 large setule. Female and male maxilla (fig. 63*e*) 2-segmented, situated lateral and slightly posterior to postoral process. First segment slightly more than four-fifths the length of second, narrower proximally and distally than medially. Second segment elongate, with small, lobate membrane on distal half of posterior surface and 2 saber-shaped terminal

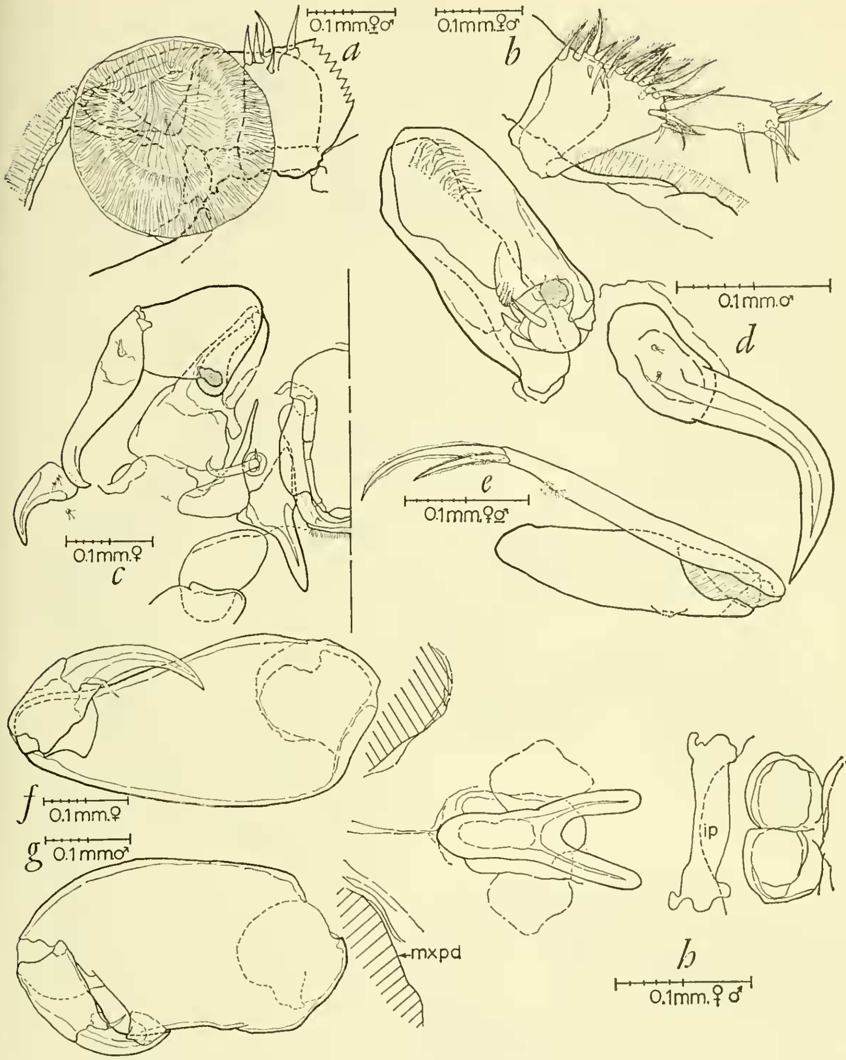


FIGURE 63.—*Caligus ligatus* Lewis, 1964, ventral view: *a*, frontal region, left side showing lunule and antennule base; *b*, left antennule; *c*, female oral region, right side showing antenna, postantennal process, mouth cone, mandible, maxillule, postoral process, and maxilla base; *d*, male left antenna and postantennal process; *e*, left maxilla; *f*, female right maxilliped; *g*, male left maxilliped; *h*, maxilliped bases (mxpd), sternal furca, interpodal plate of first thoracic leg (ip), and processes between interpodal plates of first and second thoracic legs.

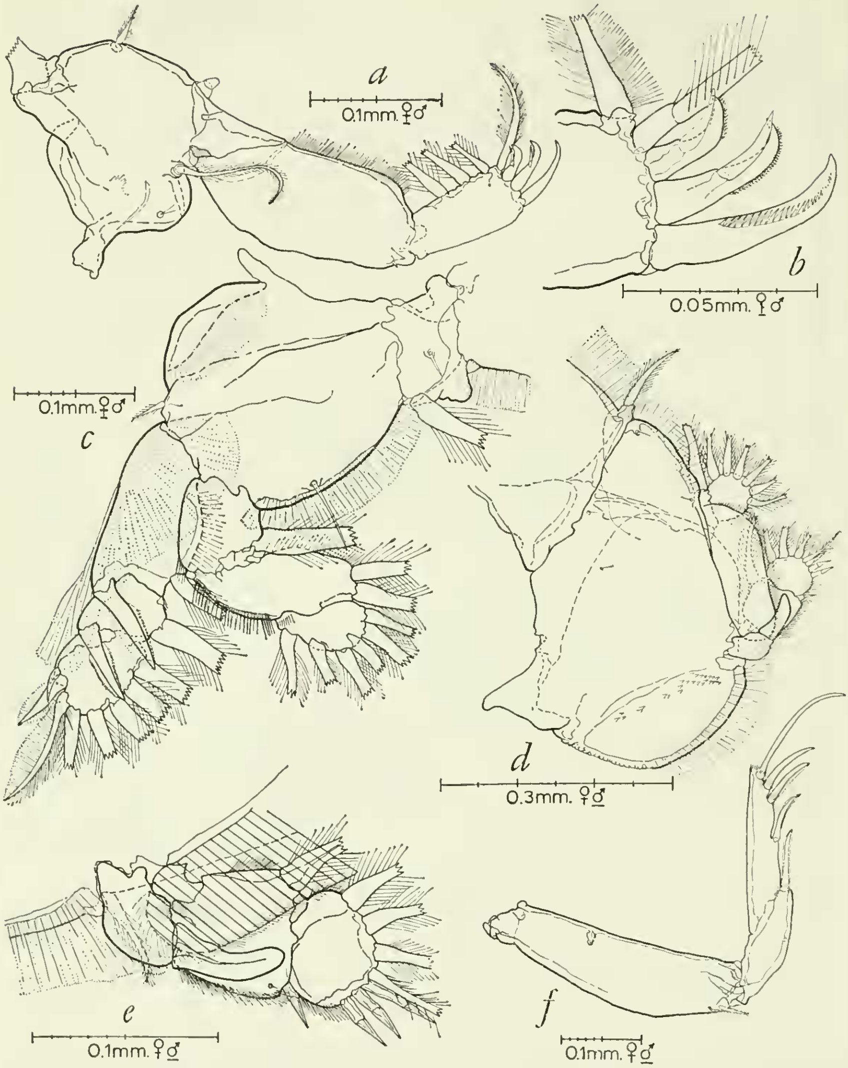


Figure 64.—*Caligus ligatus* Lewis, 1964, right thoracic legs, anterior view: *a*, first; *b*, distal region of second segment of exopodite of first; *c*, second; *d*, third; *e*, exopodite of third; *f*, fourth.

processes. Outermost terminal process approximately 1½ times the length of innermost, with fine membrane along both margins; innermost with finely serrated membrane along both margins.

Male maxilliped (fig. 63*g*) 2-segmented, situated posterior and medial to maxilla base. First segment large, strongly developed, with knoblike projection on distal half of inner surface, distal surface of knob grooved, appearing to receive distal part of terminal process of second segment when segment flexed. Second segment short, tapered from proximal end to indistinct junction with clawlike terminal process, single, setule-like accessory process present on distal inner surface of segment. First segment of female maxilliped (fig. 63*f*) not as well developed as that of male, without projection of distal inner surface. Second segment and terminal process as in male. Sternal furca situated on median longitudinal axis of body, posterior to maxilliped bases, base of furca long, lobate, tines diverging in curved manner from point of bifurcation, terminating in rounded tips.

For nature of legs and armature, see figure 64 and table 23.

Remarks.—The presence of mature females and the variation exhibited in the males in the present collection indicated that a redescription of the species was in order.

Table 23.—*Armature of thoracic legs I–IV of the female and male of* Caligus ligatus *Lewis, 1964a*

Leg	Surface	Inter-podal Plate	Protopodite		Exopodite			Endopodite		
			1	2	1	2	3	1	2	3
I	Outer		ss,p		rh	3H,P				
	Inner		p		c	3P				
II	Outer	m		m,p	m,fm,mH	dmH	h,mH,Q,P	c	C*	c,3P
	Inner		s,P	m,s	c,P	c,P	4P	P	c,2P	3P
III	Outer	m	m,d,p		s,H	c,s,p′	c,3p′	c	c,3P	
	Inner		s,P,s,m,s			c,P	c,4P	P	c,3P	
IV	Outer		p		s,fm,mH	mH,fm,mH, fm,H,fm,H				

* Condition on male, female = D.

Caligus flexispina Lewis

Caligus flexispina Lewis, 1964a, p. 149, figs. 4–5.

Distribution and hosts.—Hawaiian Islands, *Acanthurus triostegus sandvicensis*.

Material.—One female (retained by author) from the external surface of *Aulostomus chinensis* (Linnaeus), captured in a fishtrap by Samuel Kaolulo between Diamond Head, and Koko Head, Oahu, Hawaii. One male (retained by author) from the external surface of an unknown labrid captured in the Hawaiian region.

MEASUREMENTS.—(In mm) 1 female and 1 male:

	female	*male*
Total length, excluding caudal setae	2.37	2.29
Length of cephalothorax, including frontal region	1.53	1.67
Width of cephalothorax	1.21	1.26
Length of genital segment	0.59	0.38
Width of genital segment	0.68	0.38
Length of abdomen	0.20	0.20
Length of caudal rami		0.20
Length of egg strings (female nonovigerous)		

DESCRIPTION.—See Lewis, 1964a.

Caligus randalli Lewis

Caligus randalli Lewis, 1964a, p. 156, figs. 6a, b, d–f, h–l, n–q; fig. 7.

DISTRIBUTION AND HOSTS.—Hawaiian Islands, *Acanthurus triostegus sandvicensis.*

DESCRIPTION.—See Lewis, 1964a.

Caligus kalumai Lewis

Caligus kalumai Lewis, 1964a, p. 171, fig. 10.

DISTRIBUTION AND HOSTS.—Hawaiian Islands, *Acanthurus guttatus.*

DESCRIPTION.—See Lewis, 1964a.

Order Lernaeopodoida

Family Lernaeopodidae

Charopinopsis Yamaguti, 1963

DIAGNOSIS.—Female: Cephalothorax, including posteriorly removed maxilla-bearing segment, in line with rest of body, anterior portion of tergum heavily sclerotized. Trunk broader than cephalothorax, flattened dorsoventrally, without indication of segmentation, with subconical or conical projection at each posterolateral corner; with pair of long, dactyliform posterior processes medially, ventral to oviducal openings. Abdomen and caudal rami not visible. Antennule 3-segmented, subconical; antenna biramous, not chelate, exopodite broadly rounded, without externally projecting armature, endopodite 2-3 segmented (status of distalmost "segment" questionable). Maxillule with small palp, palp tipped by setule (spine?), distal surface of maxillule with 3 setules (spines?). Maxillae posterior to maxillipeds, joined at bulla, distal region convoluted, giving knoblike appearance. Maxillipeds 2-segmented, prehensile, second segment with short, clawlike terminal process.

Male: See Yamaguti, 1963, p. 251.

Charopinopsis quaternia (Wilson)

FIGURE 65

Charopinus quaternius Wilson, 1935b, p. 343, pl. 4, figs. 42–49.—Causey, 1953a, p. 11, fig. 15.
Brachiella coryphaenae Pearse, 1952a, p. 35, figs. 129–135.—Pillai, 1962a, p. 85, fig. 18.—Yamaguti, 1963, p. 248, pl. 270, fig. 7.
Charopinopsis quaternia (Wilson) Yamaguti, 1963, p. 251, pl. 271, fig. 3.

DISTRIBUTION AND HOSTS.—4 host records:

locality	*hosts*	*references*
Gulf of Mexico	*Peristedion gracilis*	
	Coryphaena hippurus	Wilson, 1935b
	Scomberomorus cavalla	Causey, 1953a
Indian Ocean	*Coryphaena hippurus*	Pillai, 1962

MATERIAL.—Nine females (USNM 112934) from the gill filaments of *Coryphaena hippurus* Linnaeus, captured 120 miles south of Oahu, Hawaii (USFWS, HMS cruise 34).

MEASUREMENTS.—(In mm) 9 females:

	mean	*range*
Total length, excluding posterior processes	6. 75	6. 23–7. 35
Length of cephalothorax	1. 54	1. 37–1. 70
Width of anterior region of cephalothorax	0. 78	0. 74–0. 85
Width of posterior region of cephalothorax (at level of maxillae)	0. 54	0. 47–0. 63
Length of "neck" between maxillae and trunk	0. 95	0. 81–1. 11
Length of trunk, excluding posterior processes	4. 38	4. 13–4. 65
Width of trunk	1. 75	1. 30–2. 00
Length of lateral-dorsal posterior processes	0. 66	0. 44–0. 85
Length of median-ventral posterior processes	2. 91	2. 48–3. 55
Length of egg strings (8 strings)	7. 54	6–53–8. 18

DESCRIPTION OF FEMALE.—Cephalothorax (fig. 65*a*) elongate, anterior part bearing small, terminally concave projection from median anterior surface, in addition to cephalic appendages (except maxillae) and maxillipeds. Posterior part of cephalothorax necklike, slightly narrower than anterior part. Trunk elongate, broader than cephalothorax, constricted at junction with cephalothorax, without indication of segmentation. Posterior end of trunk with 2 pairs of processes (fig. 65*b*), 1 short, dactyliform pair that may be curved on outer posterior surfaces; 1 long, filamentous pair on ventral posterior surface, adjacent to oviducal openings. Median posterior ventral surface of trunk with small, padlike projection appearing to contain droplets of viscous material, projection not appearing to be associated with reproductive elements. Median posterior surface essentially concave although heavily sclerotized, forming place of attachment for ovoid spermatophores that project slightly and give biconcave outline to surface.

Antennule (fig. 65*c*) 3-segmented, attached to concave frontal projection, immediately anterior and slightly lateral to labrum. Appendage flaccid, first segment broad proximally, approximately half as wide distally, with flexible, subconical projection on inner surface. Second segment short, approximately two-thirds the length of third segment; third segment rounded distally, distal surface with 2 setules. Antennae (fig. 65*d*) large, biramous, attached lateral and slightly posterior to antennule. Protopodite subrectangular, with irregular areas of heavy sclerotization. Exopodite separable from distal surface of protopodite by breaks in sclerotization, with 2 minute, knoblike projections on inner part of rounded distal surface; entire ramus, including projections, covered by filmy cuticle. Endopodite distinctly separable from distal inner surface of protopodite, apparently 3-segmented although status of terminal "segment" questionable. First and second segments subcylindrical, first slightly less than twice the length of second. Third "segment" approximately two-thirds the length of second, concave distally, with minute, setule-like projection arising from concavity.

Mandible (fig. 65*d*) rodlike, distal end flattened, inner edge rounded, without apparent denticulations. Maxillule (fig. 65*e*) situated adjacent to posterior lateral edge of mouth cone base, consisting of stalk with palp on distal half of inner surface, palp tipped by spinelike projection. Distal end of maxillule rounded, with single short, setalike process on outer edge, 2 long, setalike processes on medial and inner edge. Maxillae (fig. 65*a*) subcylindrical, flabby, distal region (fig. 65*f*) tapered to bulbous swelling formed by convolution of distal end of each maxilla; swellings enclosing tip of capstan-shaped bulla.

Maxilliped (fig. 65*g*) 2-segmented, situated posterior and medial to maxillule base, arising from small, apron-shaped projection of ventral surface of cephalothorax. First segment well developed, approximately twice the length of second, medial inner surface with knob-shaped swelling bearing small, conical projection. Second segment with wavy outline, distal third of inner surface denticulated, inner distal surface bearing setalike process. Terminal process of second segment originating on outer distal surface of segment, claw-like except for spike-shaped accessory projection on medial inner surface.

Discussion.—The Hawaiian specimens differ from Wilson's type-material (USNM 64009–64011) and Pearse's holotype and paratype slides (USNM 92663, 92688) in size, the Gulf of Mexico specimens being approximately four-fifths the length of the Hawaiian specimens (excluding posterior processes). There is also some minor variation in the size and shape of the various body regions and posterior proc-

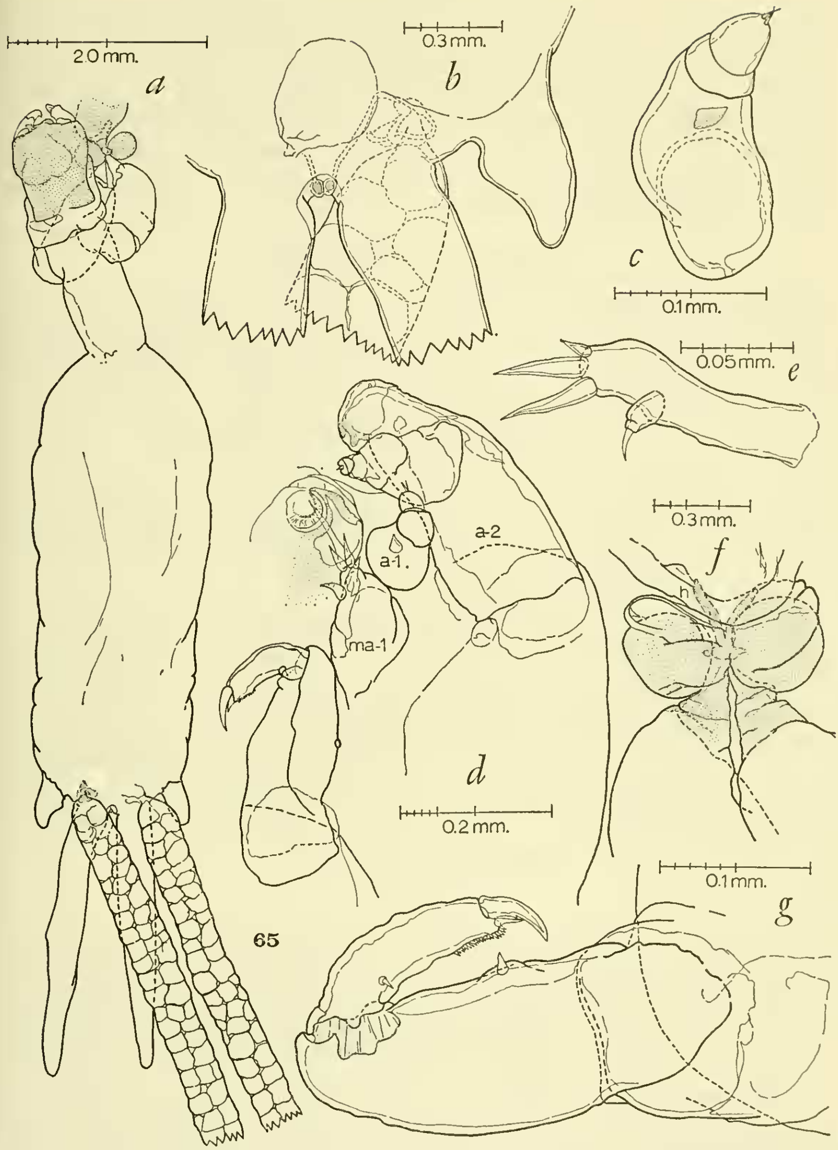


FIGURE 65.—*Charopinopsis quaternia* (Wilson, 1935), female: *a*, dorsal view (eggs drawn in free hand). Ventral view: *b*, posterior end of trunk showing posterior processes, region of genital openings, and part of one egg string; *c*, right antennule; *d*, anterior end of cephalothorax, left side showing antennule (a-1), antenna (a-2), mouth cone, mandible, maxillule (ma-1), and maxilliped; *e*, left maxillule; *f*, distal end of maxilla showing attachment with host tissue (h); *g*, right maxilliped.

esses, both in the 3 collections as a whole and individually, but the author attributes this to natural variation. Pillai (1962a, p. 86) points out that the posterior processes on the trunk of his specimens "are more narrowing towards the tip" than those described by Pearse (1952a). Pearse, however, made permanent mounts of his specimens and flattening of the specimens and their component parts has taken place, as evidenced by his figures.

Brachiella Cuvier, 1829

Diagnosis.—Female: Cephalothorax elongate, frequently at angle to trunk, anterior region of tergum heavily sclerotized. Trunk swollen, flattened dorsoventrally, with 1 or 2 pairs of posterior processes and single genital process (1 or more of these may be reduced or lacking); without recogmizable abdomen or caudal rami. Antennule 2–4 segmented, subconical; antennae biramous, exopodite with or without armature, endopodite reduced. Maxillule with palp; maxillae removed well behind maxillipeds, distally united, with bulla. Maxillipeds close to oral region, 2-segmented, second segment with clawlike terminal process.

Male: Body divisible into prosome (=cephalothorax) and urosome, separated by constriction or internal indication of constriction. Urosome longer than prosome, usually narrower, caudal rami small. Antennule 3–4 segmented, antennae biramous, exopodite 1-segmented, lobate, endopodite 2-segmented. Maxillule similar to that of female; maxilla 2-segmented, tipped with clawlike terminal process. Maxilliped 2-segmented, second segment with clawlike terminal process.

Brachiella thynni Cuvier

Figures 66, 67

B. thynni Cuvier, 1829, p. 257, pl. 15, fig. 5.—Guérin-Méneville, 1829–1844, pl. 9, fig. 6a–c.—Nordmann, 1832, p. 90.—Milne-Edwards, 1840, p. 512.—Steenstrup and Lütken, 1861, p. 420, pl. 15, fig. 36.—Van Beneden, 1851, p. 128; 1861, p. 153.—Heller, 1866, p. 756.—Van Beneden, 1870a, p. 37; 1870b, p. 244.—Vogt, 1877, pl. 3, fig. 9.—Richiardi, 1880, p. 7.—Stossich, 1880, p. 268.—Valle, 1880, p. 77.—Carus, 1885, p. 375. Bassett-Smith, 1896a, p. 162.—Brian, 1899a, p. 6.—Bassett-Smith, 1899, p. 502.—Brian, 1901, p. 1, fig. 1.—Graeffe, 1902, p. 16.—Thompson and Scott, 1903, p. 294.—Stenta, 1904, p. 345.—Miculicich, 1905a, p. 600; 1905b, p. 733.—Rathbun, 1905, p. 102.—Brian, 1905, p. 8; 1906, p. 105, pl. 9, fig. 1.—Scott and Scott, 1913, p. 204, pl. 64, figs. 4–6.—Wilson, 1915, p. 703, pl. 25, fig. C; pl. 53, figs. 209–215.—Leigh-Sharpe, 1926, p. 386.—Kirtisinghe, 1935, p. 342, figs. 40–42.—Bere, 1936, p. 613.—Bonnet, 1948, p. 7.—Causey, 1953b, p. 15.—Delamare-Deboutteville and Nunes-Ruivo, 1953, p. 217.—Shiino, 1956b, p. 283, figs. 8–9; 1958, p. 112; 1960b, p. 539.—Pillai, 1962a, p. 81, figs. 15, 16.—Shiino, 1963a, p. 346.—Yamaguti, 1963, p. 247, fig.1.—Kirtisinghe, 1964, p. 119, figs. 171, 172.

Thynnicola ziegleri Miculicich, 1904, p. 48, figs. 1–3.

DISTRIBUTION AND HOSTS.—28 host records:

locality	*hosts*	*references*
Unknown	*Scomber thynnus*	Nordmann, 1832
	"tuna"	Milne-Edwards, 1840
North Atlantic	*Thynnus thynnus*	Bassett-Smith, 1896a
	T. vulgaris	Rathbun, 1905
	"tuna"	Wilson, 1915
	Orcynnus thynnus	Scott and Scott, 1913
Equatorial Atlantic	"Albacore"	
	Sciaena aquila	
	"Baracottaer"	Steenstrup and Lütken, 1861
Baltic	*Thynnus vulgaris*	Van Beneden, 1870a
Gulf of Mexico	*Pomatomus saltatrix*	Bere, 1936
	Scomberomorus cavalla	Causey, 1953b
Hawaii	*Thynnus* species	Bonnet, 1948
	Thunnus albacares	
	Parathunnus sibi	
	Thunnus obesus	Shiino, 1963a
Japan	*Acanthocybium solandri*	Shiino, 1956b
Indian Ocean	*Chirocentrus dorab*	Thompson and Scott, 1903
	Thunnus (Germo) macropterus	Kirtisinghe, 1935
	Parathunnus obesus	
	Neothunnus albacora	Shiino, 1958
	Acanthocybium solandri	Shiino, 1960b
	Indocybium lineolatum	Pillai, 1962*a*
	Neothynnus macropterus	Kirtisinghe, 1964
Mediterranean	*Thynnus vulgaris*	Carus, 1885
	Thynnus thynnus	Brian, 1899a
	"tuna"	Brian, 1901
	Thunnus thynnus	Delamare-Deboutteville and Nunes-Ruivo, 1953

MATERIAL.—Three females and 2 males (USNM 112935) from the external surface of *Acanthocybium solandri* (Cuvier) caught in the Hawaiian region (USFWS, HMS cruise 38).

MEASUREMENTS.—(In mm) 3 females and 1 male:

	female
Total length, excluding posterior processes	9.30, 14.55, 16.13
Length of cephalothorax, including "neck"	5.85, 11.25, 10.50
Width of anterior region of cephalothorax	0.93, 1.07, 0.96
Width of posterior region of cephalothorax (at maxillae)	1.30, 1.26, 1.30
Length of trunk	3.45, 3.30, 5.63
Width of trunk	2.29, 3.48, 3.77
Length of dorsal posterior processes	5.93, 9.15, 9.15
Length of ventral posterior processes	3.90, 8.18, 9.15
Length of egg strings	6.23, 13.05, 15.90

	male
Total length	1. 85
Length of prosome	0. 76
Width of prosome	0. 53
Length of urosome	0. 91
Width of urosome	0. 53
Width at constriction between prosome and ursome	0. 24
Length of caudal rami	0. 12

Description of female.—Body (fig. 66*a*) consisting of 2 parts, anteriormost (cephalothorax) elongate, vermiform, posteriormost (trunk) flattened dorsoventrally, swollen laterally. Cephalothorax, except for maxilla-bearing segment, with heavily sclerotized tergum; maxillae arising from posterior end of cephalothorax, well posterior to maxillipeds. Swollen trunk slightly narrower anteriorly than posteriorly, lateral margins irregular. Dorsal surface of trunk flatly convex, with slight irregularities, distinctly separable from vermiform cephalothorax, without distinct evidence of segmentation. Ventral surface of trunk (fig. 66*b*) with 3 pairs of bosses, with distinct though incomplete line of division posterior to each pair, giving 4-segmented appearance. Lateral posterior surfaces projecting past slightly biconvex median portion as lobate extensions; median posterior surface bearing 4 elongate, lanceolate projections, 2 dorsally, 2 ventrally, each member of dorsal pair with knob-shaped proximal swelling. Trunk with small, knoblike projection between and ventral to base of processes. Egg strings projecting from posterior surface, between dorsal and ventral posterior processes.

Antennule (fig. 66*c*) 3-segmented, club shaped, arising from anterior ventral surface of cephalothorax, just lateral and anterior to mouth cone. First segment swollen, flabby, slightly less than twice the combined lengths of remaining 2 segments. Second segment cylindrical; third segment approximately 1½ times the length of second, rounded distally, with single, minute spinule from medial anterior surface and 2 hairlike processes distally. Antennae (fig. 66*e*) biramous, situated posterior and lateral to antennule base, extending anteriorly around anterior end of cephalothorax. Division between antenna base and cephalothorax indistinct, incomplete. Protopodite and exopodite separable only by breaks in sclerotization, forming dactyliform projection. Endopodite rudimentary, knoblike, with 3 spinules distally.

Mandible (fig. 66*f*) rodlike, wavy, flattened distally, distal inner surface with 6 denticulations (including distal end). Maxillule (fig. 66*g*) situated adjacent to lateral posterior surface of mouth cone, consisting of stalk (with indistinct evidence of segmentation) bearing node from medial posterior surface, node tipped by spinule; stalk flattened distally, distal surface with 3 nodes, each tipped by spinule.

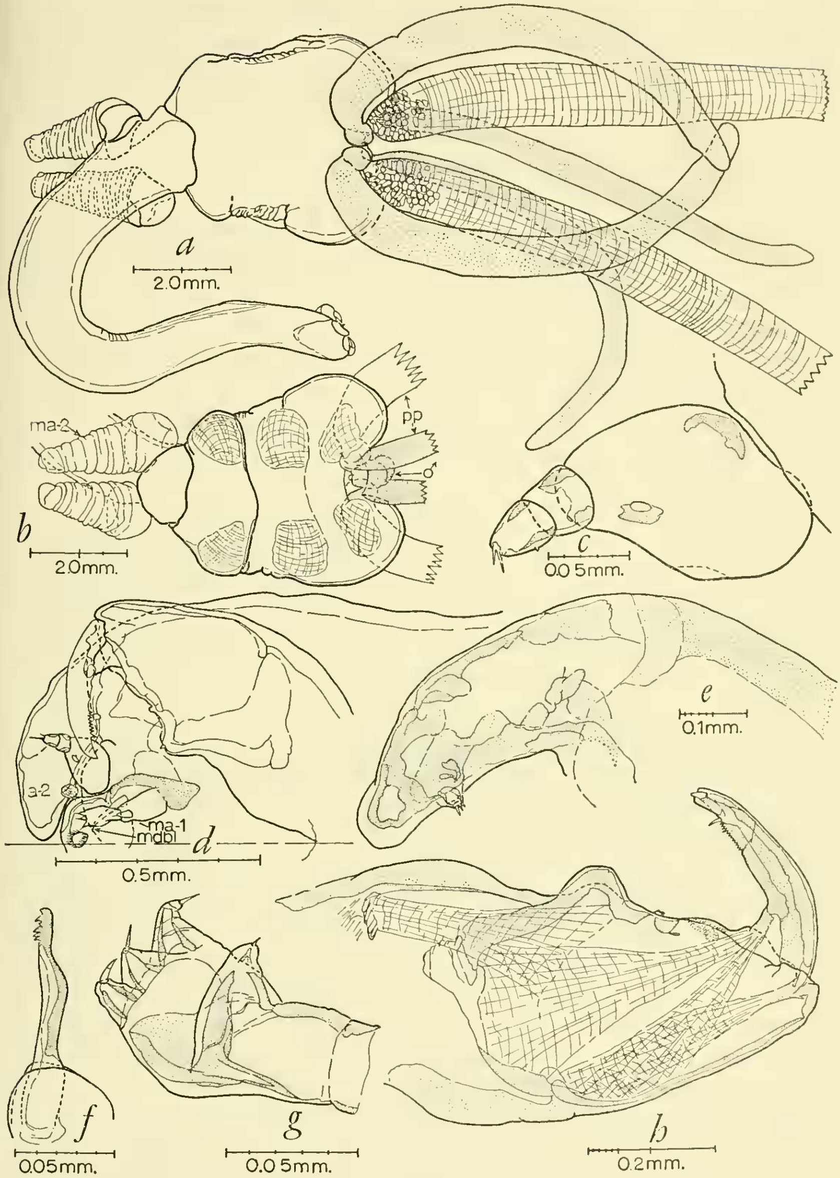


FIGURE 66.—*Brachiella thynni* Cuvier, 1829, female: *a*, dorsal view. Ventral view: *b*, posterior end of neck and trunk showing maxillae (m-2), bosses on trunk (crosshatched areas), posterior processes (pp), and attached male; *c*, left antennule; *d*, anterior end of cephalothorax, left side showing antennule, antenna (a-2), mouth cone, mandible (mdbl), maxillule (ma-1), and maxilliped; *e*, left antenna; *f*, left mandible; *g*, right maxillule (posterior view); *h*, left maxilliped, showing musculature.

226-321—67——12

Shiino (1956b) describes an accessory lamella associated with the maxillule (Shiino's "maxilla") which was not found on the dissected appendage although a cuticular flap is present on the mouth cone anterior to the maxillule. Maxilla (fig. 66*b*) subconical, with numerous superficial annulations, distal end concave on inner half and enveloping cylindrical bulla (not figured).

Maxilliped (fig. 66*h*) situated posterior and slightly lateral to mouth cone, segmentation indistinct and incomplete although musculature suggests 3-segmented condition. Appendage divisible into heavy basal part and clawlike distal part; basal part with knob-shaped projection from medial inner surface, with minute, doughnut-shaped projection just distal to knob with series of minute denticulations on distal inner surface. Clawlike distal part bluntly pointed distally, with setule-like accessory process on distal inner surface, with row of minute denticulations extending from medial inner surface to base of accessory process.

Description of male.—Cephalothorax or prosome (figs. 67*a,b*) ovoid in both lateral and dorsal view, consisting of cephalon and maxilliped-bearing segment. Division between prosome and urosome distinct, complete. Urosome broadest anteriorly, tapered to narrow posterior end; posterior end with large, lappet-like anal laminae, also bearing pair of subconical caudal rami, rami without armature elements.

Antennule (fig. 67*c*) 3-segmented, situated on lateral-anterior dorsal surface. First segment broad proximally, proximal width more than twice medial width, approximately 4 times distal width; length approximately twice combined lengths of second and third segments. First segment with spinule on distal half of anterior dorsal surface. Second segment approximately two-thirds the length of third, with spinule on distal half of anterior dorsal surface. Third segment with indentation on medial anterior surface, indentation bearing single spinule; rounded distal end with 4 setules. Antennae (fig. 67*d*) biramous, situated on anterior ventral surface of cephalothorax, below antennule base and lateral to mouth cone. Protopodite 1-segmented, originating from angular projection of ventral surface of cephalothorax. Exopodite lamellate, with spine on medial posterior surface, second spine on distal-outer posterior surface (spines not noted by Shiino, 1956b). Endopodite 2-segmented, first segment approximately twice the length of second, second with sharp indentation on distal inner surface, bearing clawlike terminal spine and small spinule from indentation.

Mouth cone projecting anteriorly from anterior ventral surface of cephalothorax, labrum and labium indistinctly separable. Labrum flat, with membranous lateral surface; labium rounded, with heavily sclerotized band distally, band bearing fine membrane projecting medially and membrane-like projection directed distally, latter topped

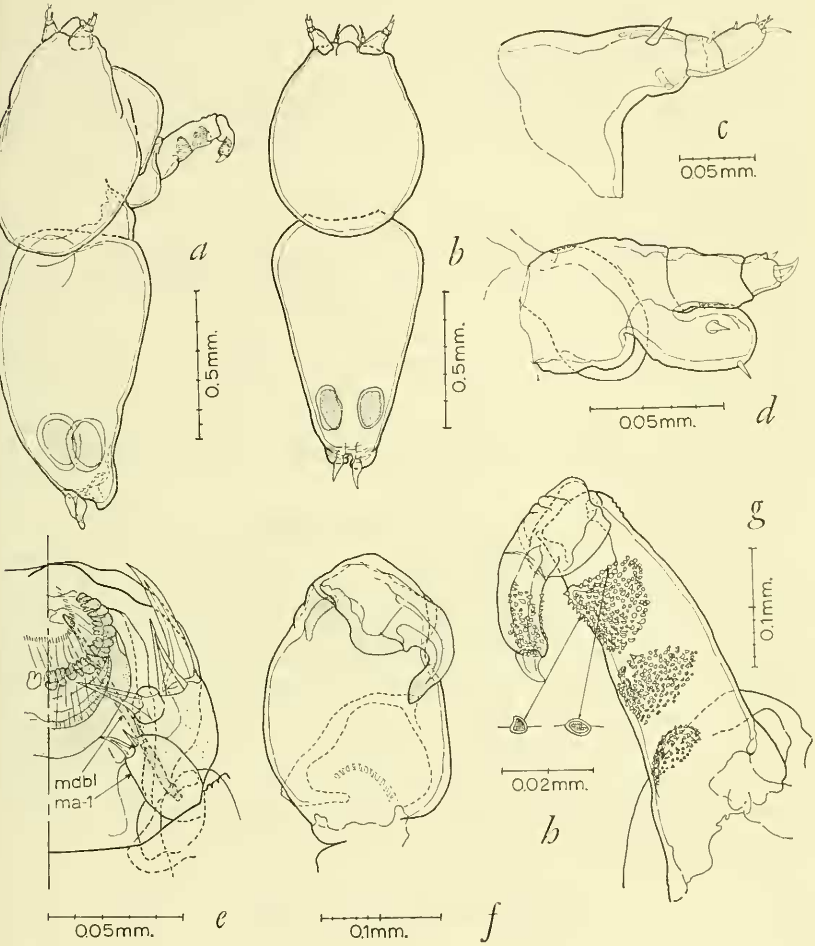


FIGURE 67.—*Brachiella thynni* Cuvier, 1829, male: *a*, lateral view; *b*, dorsal view. Ventral view: *c*, left antennule; *d*, left antenna; *e*, oral region, left side showing mouth cone, mandible (mdbl), and maxillule (ma–1); *f*, right maxilla; *g*, right maxilliped; *h*, projections on right maxilliped.

by row of small, bifid pads, pads topped by finely frilled membrane. Mandible (fig. 67*e*) rodlike, originating from padlike swelling adjacent to mouth cone. Maxillule basically similar to that of female except node on medial surface bearing 2 spinules instead of 1, distal 3 nodes not as prominent as in female. Maxillae and maxillipeds situated on irregular, apron-like projection, posterior half of projection separated from anterior half by distinct ridge. Maxillae (fig. 67*f*) well developed, 2-segmented, situated on anterior half of projection. Both maxillae connected at inner proximal end by posteriorly bifurcate band of heavy sclerotization. First segment well developed, with heavily sclerotized ring at proximal end, duct from maxillary gland visible inside proximal inner surface of appendage. Second segment fused to clawlike terminal process.

Maxilliped (fig. 67*g*) 2-segmented, situated on posterior half of apron-like projection. First segment of maxilliped elongate, with 3 adhesion surfaces on inner surface. Adhesion surfaces formed by numerous minute, padlike or hook-shaped projections (fig. 67*h*). Proximal adhesion surface associated with heavily sclerotized ridge and pad, medial surface associated with swelling, swelling with spinule; distal adhesion surface associated with swelling on distal inner surface. Second segment elongate, with adhesion process on distal half of posterior surface; terminal process short, clawlike, distinct from segment.

Discussion.—The Hawaiian specimens differ from the description given by Shiino (1956b) primarily in the characteristics of the male: the shorter cephalothorax and longer trunk, the presence of 3 instead of 2 tuberculated bulges (adhesion pads) on the first segment of the maxilliped, and the presence of 2 spinules on the exopodite of the antenna. Whether or not these differences warrant specific consideration remains questionable. The similarity of the female and the males, with the exceptions here noted, and the broad distribution of the parasite and the pelagic hosts that it characteristically parasitizes suggest, to the present author, that these differences are due to intraspecific variation.

Brachiella regia, new species

Figures 68, 69

Material.—Two females and 2 males from the gill arches of *Lampris regius* (Bonnet) captured in the Oahu region and examined by Walter Fujii, at the Honolulu Aquarium. One of the females (USNM 112936) has been designated as the holotype, 1 of the males (USNM 113033) as the allotype, and the remaining male and female (USNM 113034) have been designated as paratypes.

Measurements.—(In mm) 1 female and 1 male:

	female
Total length, excluding lateral posterior processes but including median projection	9.08
Length of cephalothorax, anterior to maxillae	4.70
Width of anterior region of cephalothorax	0.86
Length from maxillae to trunk	0.78
Width of posterior region of cephalothorax (at maxilla)	0.99
Length of trunk	3.07
Width of trunk	1.60
Length of median posterior process	1.11
Length of dorsal posterior processes	0.52
Length of ventral posterior processes	0.58
Length of egg string	2.48

	male
Total length, excluding posterior processes	3.44
Length of prosome	1.08
Width of prosome	0.90
Length of urosome	2.25
Width of urosome	0.81
Width at constriction between prosome and urosome	0.77

Description of female.—Body (fig. 68*a*) 2-parted, anterior part consisting of cephalothorax, posterior of trunk. Cephalothorax elongate, at sharp angle to longitudinal axis of trunk, consisting of cephalon and maxilliped-bearing segment; anterior third with heavily sclerotized tergum. Trunk, excluding posterior processes, approximately three-fourths the length of cephalothorax, separable from cephalothorax by distinct groove on lateral and ventral surfaces, groove not as distinct dorsally. Trunk flattened dorsoventrally, basically rectangular from dorsal viewpoint although with numerous small irregularities. Posterior end (fig. 68*c*) with 2 pairs of short, knoblike processes laterally, with rounded projection on ventral median surface.

Antennules, antennae, maxillules, maxillae, and maxillipeds covered with thick layer of cuticular material, material overlying thin, darker inner layer. Segment division of mentioned appendages not extending through outer layer although usually discernible and distinct in inner layer.

Antennule (fig. 68*e*) 3-segmented, situated on ventral anterior surface of cephalothorax. First segment large, irregular, approximately 1¼ times the combined lengths of second and third segments. Second segment slightly more than half the length of third; third segment elongate, rounded distally, distal end with 4 naked setules. Antenna (fig. 68*g*) biramous, originating from lateral anterior surface of cephalothorax. Protopodite 1-segmented, inner, darker portion of cuticle forming 3 knob-shaped proximal processes articulating with indentations on knob-shaped processes of cephalothorax. Distal end of protopodite irregular, indistinct along inner surface, at origin of endopodite. Exopodite appearing 1-segmented, approximately three-fourths the length of protopodite. Distal end of exopodite curved inward slightly, outer margin broadly convex, surface finely denticulated, inner margin broadly concave. Endopodite small, 2-segmented, first segment slightly longer than second, second with spinule on distal end.

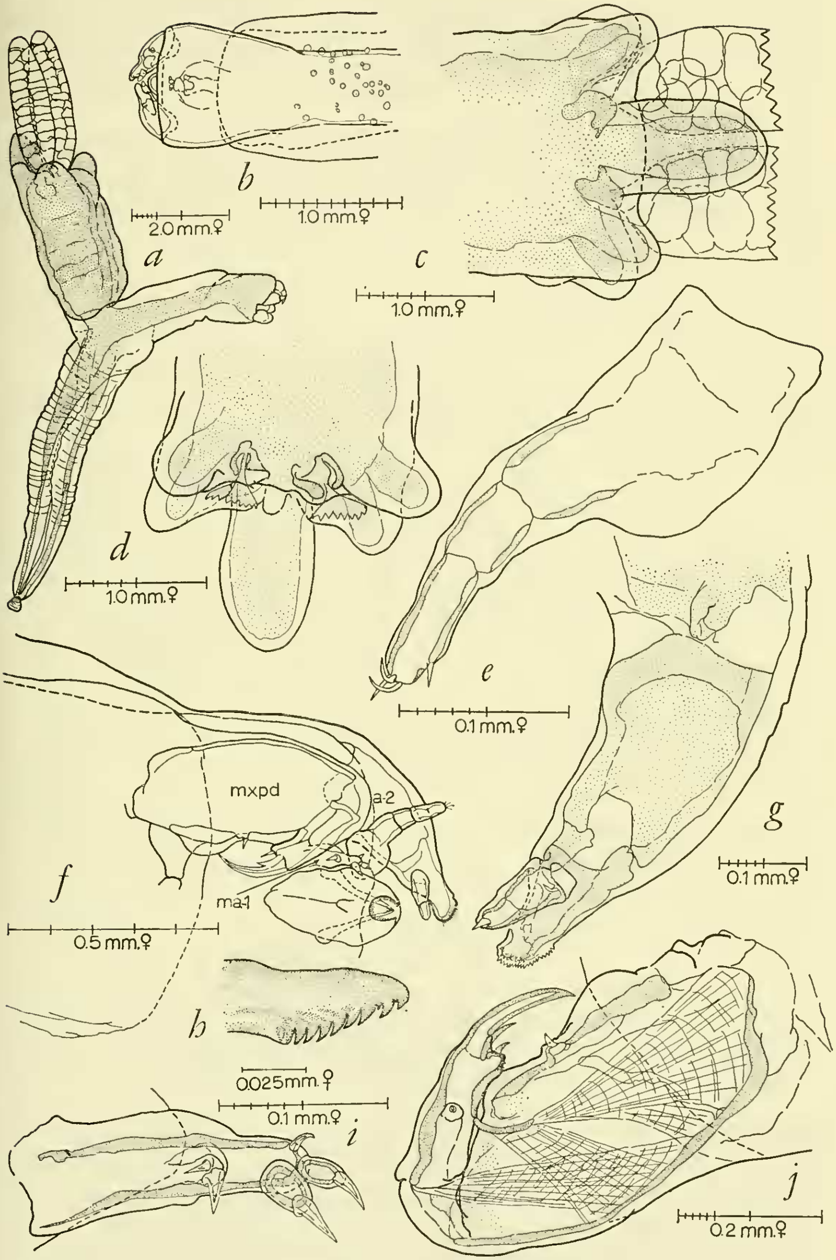
Mandible (fig. 68*h*) appearing 3-parted, proximal part broad proximally, tapered abruptly, remaining parts tapered gradually to bluntly rounded distal end. Inner surface of distal part with 8–10 primary denticulations and 2 secondary denticulations, 1 between the first and second primary denticulations, the other between the second and third. Maxillule (fig. 68*i*) situated just posterior to mandible base, consisting of stalk bearing palp on median posterior surface, palp with 2 spinules distally; distal surface of maxillule with 2 nodules and spinule, both nodules with spinule distally. Maxillae (fig. 68*a*) elongate, approximately 1¼ times the length of cephalothorax, situated at posterior end of cephalothorax, well behind maxillipeds. Maxillae separate to distal end, attached to small, top-shaped bulla.

Maxilliped (fig. 68*j*) 2-segmented, extending anteriorly from padlike ledge slightly posterior to mouth cone. First segment strongly developed, with smoothly irregular outline, bearing small, spinulelike projection from medial inner surface. Second segment elongate, with nodule on medial ventral surface, nodule bearing minute, subconical projection. Distal end of second segment irregular, with steplike indentation on inner surface, bearing 2 small, spinelike accessory processes from inner surface and single, large, clawlike terminal process.

Description of male.—Body (figs. 69*a*, *b*) tapered at both ends, lateral margins parallel throughout most of length although constric-

---

Figure 68.—*Brachiella regia*, new species, female: *a*, lateral view; *b*, anterior portion of cephalothorax, dorsal view showing irregular cuticular splotches; *c*, posterior region of trunk showing posterior processes and portion of egg strings, ventral view; *d*, same, from dorsal viewpoint with all except base of egg strings removed; *e*, left antennule, ventral view; *f*, oral region, right side showing antennule, antenna (a-2), mouth cone, mandible, maxillule (ma-1), and maxilliped (mxpd), ventral view; *g*, right antenna, ventral view; *h*, denticulated portion of mandible, lateral view [drawn by Z. Kabata]; *i*, right maxillule, ventral view; *j*, right maxilliped, ventral view.


a
2.0 mm.♀
b
1.0 mm.♀
c
1.0 mm.♀
d
1.0 mm.♀
e
0.1 mm.♀
f
mxpd
a-2
ma-1
0.5 mm.♀
g
0.1 mm.♀
h
0.025 mm.♀
i
0.1 mm.♀
j
0.2 mm.♀

tion present immediately posterior to maxillipeds in 1 specimen (not shown in figures). Posterior region with pair of unarmed subterminal dorsal flaps (caudal rami?) and pair of slightly projecting, knoblike terminal processes. Anterior third of body heavily sclerotized dorsally; mouth cone projecting anteriorly and ventrally, slightly past anterior end of cephalothorax.

Antennule (fig. 69*c*) 3-segmented, situated lateral and slightly posterior to anterior edge of mouth cone base. First segment more than 1½ times the combined lengths of second and third segments,

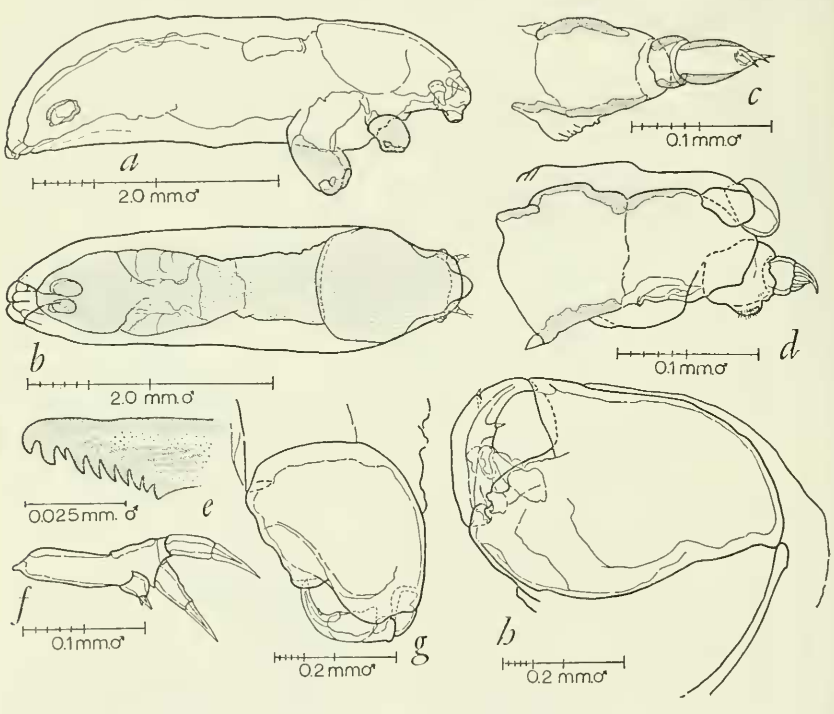


FIGURE 69.—*Brachiella regia*, new species, male: *a*, lateral view; *b*, dorsal view. Lateral view: *c*, right antennule; *d*, right antenna; *e*, denticulated portion of mandible [drawn by Z. Kabata]; *f*, right maxillule; *g*, right maxilla; *h*, right maxilliped.

broad proximally, tapered slightly to distal end. Second segment short, collar shaped; third segment dactyliform, approximately twice the length of second, distal end rounded, tipped by 3 naked setules. Antenna (fig. 69*d*) biramous, situated slightly posterior and lateral to antennule base. Protopodite 2-segmented, segments of approximately equal size, both irregular in outline. Exopodite 1-segmented, small, less than one-third the length of protopodite, broadly rounded distally, without armature. Endopodite 2-segmented, slightly more than one-third the length of protopodite. First segment approximately twice the length of second, with small, finely denticulated knob on inner surface. Distal surface of second segment flattened, with 2 small spinules on inner half and single, larger spinule on outer half.

Mandible (fig. 69*e*) appearing 3-parted, rodlike; distalmost part flattened, inner surface with 9 denticulations, the third slightly smaller and considered a secondary denticulation by Kabata (from correspondence). Maxillule (fig. 69*f*) adjacent to posterior lateral portion of mouth cone base, consisting of stalk bearing single palp on median posterior surface, palp with 2 terminal spinules; 2 elongate, spinule-tipped dactyliform processes present on distal end of maxillule. Maxilla (fig. 69*g*) prehensile, 2-segmented, situated well posterior to mouth cone base. First segment strongly developed, proximal and outer margins flatly convex, inner surface indented medially, indentation with pocket-like depression receiving terminal process of second segment when segment flexed. Second segment short, heavily sclerotized, fused with clawlike terminal process, and bearing minute, spinelike accessory process on inner surface.

Maxilliped (fig. 69*h*) 2-segmented, originating from irregular projection immediately posterior to maxillae. First segment strongly developed, narrow proximally, flared to broad distal half; inner surface indented distally, indentation with small concavity receiving terminal process of second segment when segment flexed. Second segment small, heavily sclerotized, fused with clawlike terminal process, bearing small, spinelike accessory process from inner surface and minute, spinule-like process from outer surface.

Discussion.—The species is placed in the genus *Brachiella* because the female cephalothorax is elongate and cylindrical, is flexed backward, and is "covered" by a heavily sclerotized tergum. Additionally, the trunk of the female is swollen and flattened dorsoventrally, there are 4 pairs of posterior processes, an unpaired genital process is present, and there is no visible abdomen or caudal rami. The characteristics of the male cast some doubt on the inclusion of the species in *Brachiella*. The prosome and urosome of the figured specimen are in an essentially straight line although the urosome of the second male specimen is at an angle to the prosome. The author is deeply indebted to Dr. Z. Kabata for a rather exhaustive examination of the paratype material and a comparison of the male with the male of *Andropoda lampri* (Scott, 1901). Based upon the comparison of the males of *B. regia* and *A. lampri* and upon the similarity of the female of *B. regia* with other members of the genus *Brachiella*, the species is presently placed within this genus.

The female of *Brachiella regia* shows some affinities with species such as *B. concava* Wilson, 1913, and *B. gracilis* Wilson, 1908, in the nature of the cephalothorax and maxillae. Additionally, the short posterior processes of the female are comparable with those of *B. pteroplateae* Yamaguti and Yamasu, 1959, *B. bera* Yamaguti, 1939c, and *B. mitrata* Wilson, 1915. The combination of the long reflexed cephalothorax, the long maxillae, the short posterior processes, and the large genital process is, however, unique.

The male shows some affinities with the male of *B. thynni* Cuvier, 1829, in the general nature of the body. The appendages of the cephalothorax, however, are strongly reminiscent of those of *Andropoda lampri* (Scott, 1901), although the mandible has one denticulation that Kabata (correspondence) terms a secondary tooth, while the denticulations in *A. lampri* are homogeneous. There is some variation in the denticulation of the mandible of both the female and the male, the female possessing 8–10 primary denticulations, the male "secondary tooth" being slightly larger in the unfigured male than in the figured male. Further, the posterior end of the male of *B. regia* does not protrude as in *Andropoda lampri*, and the posterior processes are not as distinct and do not project past the thick, heavily sclerotized cuticle.

The species name is derived from the name of the host, *Lampris regius*.

Family Naobranchiidae

Naobranchia Hesse, 1863

Diagnosis.—Female: Cephalothorax elongate, vermiform; trunk swollen, anterior end including maxilla-bearing segment. Abdomen and caudal rami usually distinct although sometimes covered by egg masses. Eggs enclosed in membranous extension of cuticle, enveloping posterior and at least part of lateral surface of trunk. Antennule 2–5 segmented; antenna biramous. Mandible rodlike. Maxillule bipartite, with or without palp; maxilla foliaceous, usually with muscle bands extending length of appendage, forming organ of attachment that envelops gill filaments of host. Maxilliped 2-segmented, second segment fused with clawlike terminal process. Oval adhesion pads or cup-shaped structures may be present adjacent to maxillipeds.

Male: See Yamaguti, 1963, p. 303.

Naobranchia species

Figure 70

Material.—One female (USNM 112937) from gill cavity of spotted moray eel from Honolulu Aquarium.

MEASUREMENTS.—(In mm) 1 female:

	female
Total length, including egg masses	3. 75
Length of cephalothorax, to maxillae	2. 30
Length of cephalothorax, to maxillipeds	0. 36
Width of anterior region of cephalothorax	0. 37
Width of posterior region of cephalothorax, just anterior to maxillae	0. 94
Length from anterior to posterior end of maxillae	0. 94
Width of base of maxillae	0. 80
Length of trunk	2. 00
Width of trunk	2. 33

DESCRIPTION OF FEMALE.—Body (figs. 70*a*, *b*) separable into 2 parts, vermiform cephalothorax and broad, posteriorly rounded trunk. Anterior end of cephalothorax slightly expanded, from dorsal viewpoint; tapered to narrow, rounded end, in lateral view, ventral surface bearing antennules, antennae, mandibles, maxillules, and maxillipeds. Margin of anterior end of cephalothorax with heavily sclerotized band broken by several minute swellings associated with minute channels through band, similar to nodules bearing hairlike processes on caligoids. Remaining part of cephalothorax irregular (irregularities may be due to preservation), with several superficial, incomplete annuli. Trunk expanded, rounded from dorsal and ventral viewpoints, overlapping dorsal posterior end of cephalothorax; lateral and posterior surfaces covered by egg cases, cases projecting dorsally at flat angle giving semi V-shaped appearance in transverse section. No abdomen visible although possibly covered by egg cases; caudal rami not distinct although 2 minute, knoblike projections present between egg cases at posterior end of trunk, projections not visible unless egg cases separated. Outer covering of egg cases appearing thick, with moderately sclerotized band on lateral region.

Because of the small size of the appendages, with the exception of the second maxillae and maxillipeds, the presence of only a single specimen in the collection and the resultant hesitancy to dissect the appendages, the following description should be used with some caution.

Antennule (fig. 70*d*) situated on lateral-median ventral surface of cephalothorax, behind anterior end of body and slightly lateral to mouth cone. Appendage 3-segmented, first segment longer than combined lengths of remaining 2 segments; third segment bearing 4 minute, subconical projections. Antenna (fig. 70*e*) situated between antennule and base of labrum, appearing uniramous; 2-segmented, tipped by clawlike projection. Mouth cone distinct though small, with distinct space between labrum and labium. Labrum appearing pointed distally, with heavily sclerotized band medially; labium with U-shaped opening distally. Mandible (fig. 70*e*) rodlike, flattened distally, with approximately 6 falciform denticulations along distal inner margin. Maxillule (fig. 70*e*) nodular, situated adjacent to posterior lateral surface of labium base, with 2 setule-like projections distally. Maxillae (fig. 70*f*) fused, foliaceous, situated at posterior

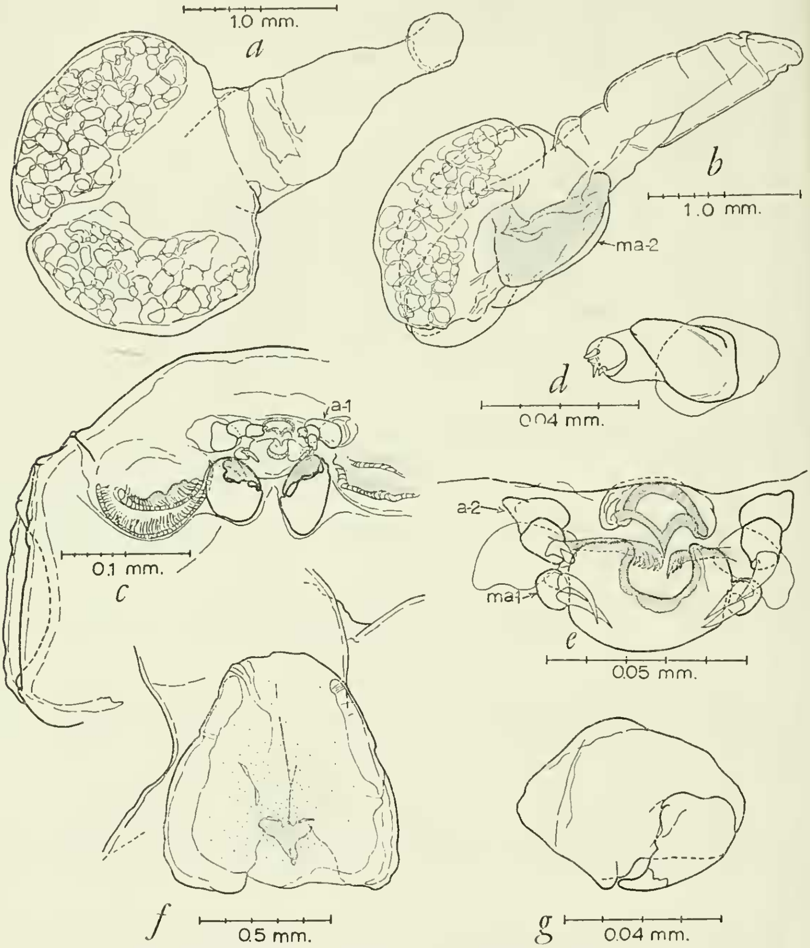


FIGURE 70.—*Naobranchia* species, female: *a*, dorsal view; *b*, lateral view (ma-2=maxillae). Ventral view: *c*, anterior end of cephalothorax showing antennules (a-1) (antennae hidden under antennules and not visible), mouth cone, maxillules, maxillipeds, and cup-shaped structure lateral to mouth cone; *d*, left antennule; *e*, oral region showing antenna (a-2), mouth cone, mandibles, and maxillule (ma-1); *f*, maxilla; *g*, right maxilliped.

end of vermiform cephalothorax and included in anterior portion of trunk. Fused maxillae forming obcordate ventral projection, fusion appearing to be at distal ends of maxillae, not with body; maxillae without distinct muscle bands.

Maxilliped (fig. 70*g*) 2-segmented, situated in small concavity slightly posterior and lateral to labium base. First segment with shelflike indentation on distal half of inner surface, shelf with pair of nodules forming depression receiving distal end of second segment terminal process when segment flexed. Second segment small, subconical, tipped by indistinctly separable, claw-shaped terminal process.

Semicircular cuplike cuticular (?) formation present lateral to maxilliped base, extending anteriorly to region of antennule base. Posterior surface of formation with pair of membranous, flangelike projections bearing fine indistinct grooves.

Discussion.—The single specimen has several distinctive features. The presence of the semicircular cuplike formation (adhesion pads?) is found in *N. aulopi* Yamaguti (1939c), although in this species they are oriented in a longitudinal direction while in the Hawaiian specimen they are oriented laterally. The apparent lack of muscle bands in the maxillae and the fusion of these 2 appendages to each other and not the body surface may be diagnostic although it may instead suggest an immature condition as Pearse (1952a, fig. 126) indicates for *N. spinosa* Pearse. The possible immature condition of the specimen may also explain the distinctive cuplike structures. Yamaguti (1939c) figures a distinct cuplike structure for a 3.2 mm specimen of *N. aulopi* while Shiino (1958) states "striated pads just behind 2nd maxillipeds [= maxillipeds] rather low and inconspicuous" in a 5.07 mm specimen of *N. aulopi*. Both of these authors figure the adult female with eggs so that if this is a characteristic of immature specimens, the pad is still present at the time ovulation commences. In adult female specimens of *N. variabilis* Brian, deposited by R. Bere in the U.S. National Museum (79146), there is no distinct process of this type although there is a slight concavity in the same region and curved, heavily sclerotized rodlike structures are visible in the cuticle.

The Hawaiian specimen appears to most closely resemble *N. variabilis* Brian. The similarity is not only in the general shape of the body in the 3-segmented antennule although Pillai (1962a) describes a 5-segmented appendage for this species. The antenna of the Hawaiian specimen is here described as uniramous although with some question. The maxillules and maxillipeds also are similar to those described for *N. variabilis* by Bere (1936) and Pillai (1962a).

Host-Parasite List

The list given below provides the scientific and common name of the host, when available, and the parasitic copepods taken from it in Hawaiian waters. The list includes the copepods described in the present paper and in Lewis, 1964a,b, 1966. With few exceptions, the hosts are arranged in the same sequence used by Gosline and Brock (1960) in their "Handbook of Hawaiian Fishes."

host	*copepod parasites*
Carcharodon carcharias (white shark)	*Anthosoma crassum*
	Dinematura latifolia
Prionace glauca (great blue shark)	*Pandarus satyrus*
	Phyllothyreus cornutus
Galeocerdo cuvier (tiger shark)	*Nesippus crypturus*
	Alebion echinatus
Pterolamiops longimanus (whitetip shark)	*Pandarus cranchii*
Carcharhinus melanopterus? (blacktip shark)	*Pandarus smithii*
Sphyrna lewini (hammerhead shark)	*Kroyeria praelongacicula*
	Pandarus cranchii
	Alebion echinatus
	Paeon vaissierei
Hexanchus griseus?	*Demoleus heptapus*
Unidentified sharks	*Alebion gracilis*
	Dinematura latifolia
	Pandarus cranchii
	Pandarus smithii
?*Aetobatus narinari* (eagle ray)	*Trebius caudatus*
Saurida gracilis (lizard fish)	*Caligus kala*
Muraenidae (moray eels)	*Pseudotaeniacanthus puhi*
	Naobranchia species
Fistularia petimba (cornet fish)	*Dentigryps bifurcatus*
Aulostomus chinensis (trumpet fish)	*Nesippus costatus*?
	Dentigryps bifurcatus
	Caligus ligatus
	Caligus flexispina
Holocentrus xantherythrus	*Caligus ligatus*
Myripristis pralinius	*Nesippus costatus*?
Lampris regius	*Brachiella regia*
Sphyraena barracuda	*Midias lobodes*
Pranesus insularum?	*Caligus ligatus*
Seriola dumerilii (yellowtail)	*Nesippus costatus*?
Caranx melampygus?	*Dentigryps ulua*
	Caligus longipedis
Coryphaena hippurus (dolphin)	*Euryphorus nordmanni*
	Caligus coryphaenae
	Caligus quadratus
	Charopinopsis quaternia

host	*copepod parasites*
Mulloidichthys auriflamma	*Hatschekia breviramus*
Parupeneus pleurostigma	*Lepeophtheirus dissimulatus*
Chaetodon fremblii	*Dentigryps bifurcatus*
	Caligus kapuhili
Chaetodon quadrimaculatus	*Lepeophtheirus dissimulatus*
Chaetodon miliaris	*Nesippus costatus*?
	Caligus kapuhili
Dascyllus albisella	*Caligus kala*
	Caligus ligatus
Pomacentrus jenkinsi	*Caligus kala*
Bodianus bilunulatus	*Dentigryps bifurcatus*
Unidentified labrid	*Caligus flexispina*
Scarus species	*Nesippus costatus*?
Zanclus canescens	*Nesippus costatus*?
Acanthurus guttatus	*Caligus kalumai*
Acanthurus nigroris	*Nesippus costatus*?
Acanthurus olivaceus	*Dentigryps bifurcatus*
	Lepeophtheirus dissimulatus
	Peniculus calamus?
Acanthurus dussumieri	*Caligus ligatus*
	Lepeophtheirus dissimulatus
	Peniculus calamus?
Acanthurus xanthopterus	*Nesippus costatus*?
Acanthurus mata	*Peniculus calamus*?
Acanthurus triostegus sandvicensis	*Nesippus costatus*?
	Dentigryps bifurcatus
	Lepeophtheirus dissimulatus
	Caligus flexispina
	Caligus randalli
	Peniculus calamus?
Ctenochaetus strigosus	*Nesippus costatus*?
	Peniculus calamus?
Zebrasoma flavescens	*Lepeophtheirus dissimulatus*
Naso lituratus	*Norion expansus*
Naso hexacanthus	*Norion expansus*
	Dentigryps bifurcatus
	Anuretes serratus
	Anuretes menehune
	Lepeophtheirus dissimulatus
	Caligus kala
	Caligus ligatus
	Peniculus calamus?
Naso unicornis	*Anuretes menehune*
	Lepeophtheirus? *fallolunulus*
	Peniculus calamus?
Acanthocybium solandri (wahoo, ono)	*Gloiopotes hygomianus*
	Brachiella thynni
Auxis thazard (frigate mackerel)	*Caligus productus*
Katsuwonus pelamis (skipjack)	*Caligus coryphaenae*
	Caligus productus
	Caligus bonito

host	*copepod parasites*
Euthynnus yaito (little tuna)	*Caligus coryphaenae*
	Caligus asymmetricus
	Caligus productus
	Caligus pelamydis
Neothunnus macropterus (yellowfin tuna)	*Elytrophora brachyptera*
	Caligus productus
Parathunnus sibi	*Elytrophora brachyptera*
	Brachiella thynni
Thunnus albacares (*in* Shiino, 1963a)	*Brachiella thynni*
Thunnus obesus (*in* Shiino, 1963a)	*Brachiella thynni*
Istiompax marlina? (black marlin)	*Gloiopotes huttoni*
Makaira ampla? (Pacific blue marlin)	*Gloiopotes huttoni*
Makaira audax (striped marlin)	*Pennella histiophori*?
	Gloiopotes huttoni
Remoropsis brachypterus	*Pennella* species
Rhombochirus osteochir	*Lepeophtheirus crassus*
Pervagor spilosoma	*Peniculus calamus*?
Ostracion lentiginosus	*Anchistrotos moa*
Diodon holocanthus	*Nesippus costatus*?
Plankton	*Caligus coryphaenae* (immature male)

Literature Cited

(*Reference not seen by author.)

BAIRD, W.

1847. On a new species of *Pennella*. Ann. Mag. Nat. Hist., vol. 19, p. 280, 1 fig.

BARNARD, K. H.

1955. South African parasitic Copepoda. Ann. South African Mus., vol. 41, no. 4, pp. 223–312, figs. 1–33.

1957. Additions to the fauna-list of South African Crustacea. Ann. Mag. Nat. Hist., ser. 12, vol. 10, pp. 1–12, figs. 1–8.

BASSETT-SMITH, P. W.

1896a. A list of the parasitic Copepoda of fish obtained at Plymouth. Journ. Mar. Biol. Assoc. United Kingdom, vol. 4, no. 2, pp. 155–163.

1896b. Notes on the parasitic Copepoda of fish obtained at Plymouth, with descriptions of new species. Ann. Mag. Nat. Hist., ser. 6, vol. 18, pp. 8–16, pls. 3–6.

1898a. Further new parasitic copepods found on fish in the Indo-Tropical region. Ann. Mag. Nat. Hist., ser. 7, vol. 2, pp. 77–98, pls. 3–6.

1898b. Some new or rare parasitic copepods found on fish in the Indo-Tropical Region. Ann. Mag. Nat. Hist., ser. 7, vol. 2, pp. 357–372, pls. 10–12.

1899. A systematic description of parasitic Copepoda found on fishes, with an enumeration of the known species. Proc. Zool. Soc. London, pp. 437–507.

BERE, RUBY

1936. Parasitic copepods from Gulf of Mexico fish. American Midl. Nat., vol. 17, no. 3, pp. 577–625, pls. 1–12.

BONNET, D.

1948. Some parasitic copepods from Hawaiian fishes. Proc. Hawaiian Acad. Sci., no. 23, p. 7.

BRADY, G. S.

*1910. Die marinen Copepoden, 1: Üeber die Copepoden der Stämme Harpacticoida, Cyclopoida, Notodelphyoida und Caligoida. No. 8 (vol. 5) *in* Zoology (vol. 11) *in* Drygalski, Deutsche Südpolar-Expedition 1901–1903, pp. 497–593.

BRIAN, ALESSANDRO

1898. Catologo di copepodi parassiti dei pesci della Liguria. Atti Soc. Ligustica Sci. Nat. Geogr., vol. 9, pp. 5–31, pls. 1–4.

1899a. Di alcuni crostacei parassiti dei pesci dell'Isola d'Elba. Atti Soc. Ligustica Sci. Nat. Geogr., vol. 10, pp. 3–10, figs. 1–5.

1899b. Crostacei parassiti dei pesci dell'Isola d'Elbe, 2: Contribuzione. Atti Soc. Ligustica Sci. Nat. Geogr., vol. 10, pp. 197–207.

1901. Caso di anomalia verificatosi su di una *Brachiella* del Tonno. Bull. Mus. Zool. Anat. Comp. Univ. Genova, 3 pp., 1 fig.

1903. Sulla *Lophoura edwardsii* Kolliker e sopra alcuni altri copepodi del Golfo di Genova. Atti Soc. Ligustica Sci. Nat. Geogr., vol. 14, pp. 3–11.

226-321—67——13

Brian, Alessandro

1905. Sui copepodi raccolti nei golfo di Napoli da Oronzio G. ed Achille Costa. Ann. Mus. Zool. Regia Univ. Napoli, n.s., vol. 1, no. 24, pp. 1-11, pls. 3–4.

1906. Copepodi parassiti dei pesci d'Italia, 191 pp., 21 pls.

1908. Note préliminaire sur les copépodes parasites des poissons provenant des campagnes scientifiques de S.A.S. le Prince Albert Ier de Monaco ou déposés dans les collections du musée oceanographique. Bull. Inst. Oceanogr. Monaco, no. 110, pp. 1–19, figs.1–7.

*1912. Copépodes parasites des poissons et des échinidés provenant des Campagnes Scientifiques de S.A.S. le Prince Albert Ier de Monaco (1886–1910). Vol. 38 *in* Albert Honoré Charles, Resultats de Campagnes Scientifiques accomplies sur son Yacht . . . , 58 pp.

1913. Di una nuova specie de *Hatschekia* Poche (*Clavella* Oken) copepode parassita del *Crenilabrus pavo.* (*H. subpinguis* n. sp.). Estr. Monit. Zool. Italiano, vol. 24, no. 3, pp. 60–65, pl. 3.

1924. Parasitologia Mauritanica: Matériaux pour la faune parasitologique en Mauritanie. Bull. Com. Etud. Hist. Sci. Afrique Occ. Franc., vol. 1, no. 1, pp. 1–66, figs. 1–67.

1935. I *Caligus* parassiti dei pesci del Mediterraneo (Copepodi). Estr. Ann. Mus. Civ. Stor. Nat. Genova, vol. 57, no. 7, pp. 152–211, figs. 1–20.

Capart, André

1953. Quelques copépodes parasites de poissons marins de la région de Dakar. Bull. Inst. Français d'Afrique Noire, vol. 15, no. 2, pp. 646–671, figs. 1–10.

1959. Copépodes parasites. In Expédition Océanographique Belge dans les Eaux Côtières Africaines de l'Atlantique Sud (1948–1949): Résultats scientifiques, vol. 3, no. 5 pp. 56–126, figs. 1–37.

Carus, J. V.

1885. Coelenterata, Echinodermata, Vermes, Arthropoda. Vol. 1 of Prodromus faunae Mediterraneae sive descriptio animalium Maris Mediterranei incolarum . . . , XI + 525 pp.

Causey, David

1953a. Parasitic Copepoda from Grand Isle, Louisiana. Occ. Pap. Mar. Lab. Louisiana State Univ., no. 7, 18 pp., 3 pls.

1953b. Parasitic Copepoda of Texas coastal fishes. Publ. Inst. Mar. Sci. Univ. Texas, vol. 3, no. 1, pp. 7–16, figs. 1–15.

1955. Parasitic Copepoda from Gulf of Mexico fish. Occ. Pap. Mar. Lab. Louisiana State Univ., no. 9, 19 pp., 3 pls.

1960. Parasitic Copepoda from Mexican coastal fishes. Bull. Mar. Sci. Gulf and Caribbean, vol. 10, no. 3, pp. 323–337, figs. 1–2.

Claus, C.

1864. Beiträge zur Kenntniss der Schmarotzerkrebse. Zeitschr. Wiss. Zool., vol. 14, pp. 365–383, pls. 33–36.

Cuvier, G. L.

*1829. Le Règne Animal, vol. 3, pp. 255–258; vol. 4, pp. 189–202.

Dana J. D.

1853; 1855. Crustacea. Pt. 2 *of* vol. 13 *in* United States Exploring Expedition during the years 1838, 1839, 1840, 1841, 1842 under the command of Charles Wilkes, U.S.N., 1618 pp. (1853); atlas, 27 pp., 96 pls. (1855).

Delamare-Deboutteville, Claude, and Nunes-Ruivo, L. P.
1951. Étude de *Pennella remorae* Murray et remarques sur la biologie et la systématiques des *Pennella* Öken. Rev. Fac. Ciênc. Lisboa, ser. 2ª, vol. 1, no. 2, pp. 341–352, figs. 1–9.
1953. Copépodes parasites des poissons méditerranéens. Vie et Milieu, vol. 4, no. 2, pp. 201–218, figs. 1–9.
1954. Parasites des poissons de mer ouest-africains récoltés par M. J. Cadenat. Bull. Inst. Français d'Afrique Noire, ser. A, vol. 16, no. 1, pp. 139–166, figs. 1–16.

Edmondson, C. H.
1946. Reef and shore fauna of Hawaii. Bernice P. Bishop Mus. Spec. Publ. 22, Honolulu, iii + 381 pp., 223 figs.

Fage, L.
1931. Remarques sur le parasitisme des copépodes du genre *Pennella.* Bull. Soc. Zool. France, vol. 56, no. 1, pp. 190–193.

Fowler, H. W.
1912. Crustacea of New Jersey. Ann. Rep. New Jersey State Mus., 1911, 651 pp., 150 pls.

Gerstaecker, A.
1853. Ueber eine neue und eine weniger gekannte Siphonostomen gattung. Arch. Naturg., vol. 19, no. 1, pp. 58–70, pls. 1–3.

Gosline, W. A., and Brock, V. E.
1960. Handbook of Hawaiian fishes, ix + 372 pp., 277 figs.

Graeffe, E.
*1902. Übersicht der Fauna des Golfes von Triest nebst Notizen über Vorkommen, Lebensweise, Erscheinungsung Laichzeit der einzelnen Arten, 5: Crustacea. Arb. Zool. Inst. Wien, vol. 13, pp. 3–17.

Guérin-Méneville, F. E.
*1829–1844. Crustacés. Vol. 2 *of* Iconographie du règne animal.

Guiart, J.
1913. Crustacés commensaux et parasites de la baie de Concarneau. Bull. Inst. Océanogr. Monaco, no. 264, pp. 1–11, figs. 1–2.

Heegaard, P.
1940. Some new parasitic copepods (Chondracanthidae and Lernaeopodidae) from western Australia. Vidensk. Medd. Dansk. Naturh. Foren., vol. 104, pp. 87–101, figs. 1–28.
1943a. Some new caligids from the Gilbert Islands. Ark. Zool., vol. 34A, no. 16, pp. 1–12, figs. 1–3.
1943b. Parasitic copepods mainly from tropical and Antarctic seas. Ark. Zool., vol. 34A, no. 18, pp. 1–37, figs. 1–94.
1945. Some parasitic copepods from fishes in the Uppsala University collections. Ark. Zool., vol. 35A, no. 18, pp. 1–27, figs. 1–54.
1949. Notes on parasitic copepods. Vidensk. Medd. Dansk. Naturh. Foren., vol. 111, pp. 235–245, figs. 1–10.
1955. Parasitic copepods from tropical west Africa. Atlantide Rep. 3, pp. 41–56, figs. 1–20.
1962. Parasitic Copepoda from Australian waters. Rec. Australian Mus., vol. 25, no. 9, pp. 149–233, figs. 1–250.

Heller, C.
1865. Crustaceen. No. 8 *in* vol. 2 of Zoologischer Theil *in* Reise der Oesterreichischen Fregatte *Novara* . . in den Jahren 1857, 1858, und 1859 . . . , 280 pp., 25 pls.

HELLER, C.

1866. Carcinologische Beiträge zur Fauna des adriatischen Meeres. Verh. Kais.-Königl. Zool.-Bot. Ges. Wien, pp. 723–760.

HESSE, C. E.

*1863. Recherches sur quelques Crustacés rares ou nouveaux des côtes de France, 3me Mem.: *Naobranchia cygniformis*. Ann. Sci. Nat., ser. 4, vol. 20, pp. 101–132, 1 pl.

1878. Description des crustacés rares ou nouveaux des côtes de France. Ann. Sci. Nat., vol. 8, no. 14, pp. 1–34, pls. 19–21.

HEWITT, G. C.

1963. Some New Zealand parasitic Copepoda of the family Caligidae. Trans. Roy. Soc. New Zealand, Zool. vol. 4, no. 3, pp. 61–115, figs. 1–14.

1964a. A redescription of *Gloiopotes huttoni* (Thomson, 1889), with a key to the species of the genus. Trans. Roy. Soc. New Zealand, Zool., vol. 5, no. 8, pp. 85–96, figs. 1–16.

1964b. A new species of *Caligus* (Copepoda) on a species of *Tripterygion* from New Zealand. Trans. Roy. Soc. New Zealand, Zool., vol. 5, no. 10, pp. 123–130, figs. 1–2.

HO, JU-SHEY

1963. On five species of Formosan parasitic copepods belonging to the suborder Caligoida. Crustaceana, vol. 5, no. 2, pp. 81–98, figs. 1–22.

HOLTEN, H. S.

1802. *Lernaea merluccii* og *exocoeti* to nye Arter. Skr. Naturh. Selsk. Kjöbenhavn, vol. 2, pp. 135–137.

HUMES, A. G., and ROSENFIELD, D. C.

1960. *Anchistrotos occidentalis* C.B. Wilson, 1924 (Crustacea, Copepoda), a parasite of the orange filefish. Crustaceana, vol. 1, no. 3, pp. 179–187, figs. 1–26.

HUTTON F.W.

*1904. Index Faunae Novae Zealandiae, viii + 372 pp.

KABATA, Z.

1965a. *Andropoda*, a new genus of Lernaeopodidae (Copepoda) from the gills of *Lampris luna* (Gmelin). Crustaceana, vol. 8, no. 2, pp. 213–221, figs. 1–2.

1965b. Copepoda parasitic on Australian fishes, IV: Genus *Caligus* (Caligidae). Ann. Mag. Nat. Hist., ser. 13, vol. 8, pp. 109–126, figs. 1–6.

KIRTISINGHE, P.

1932. *Pennella zeylanica* n.sp., a parasitic copepod of *Histiophorus gladius* Day. Parasitology, vol. 24, pp. 137–139, figs. 1–5.

1934. *Gloiopotes watsoni* n.sp. and *Lernaeenicus seeri* n.sp., parasitic copepods of fish from Ceylon. Parasitology, vol. 26, no. 2, pp. 167–175, figs. 1–21.

1935. Parasitic copepods of fish from Ceylon. Parasitology, vol. 27, no. 3, pp. 332–344, figs. 1–46.

1937. Parasitic copepods of fish from Ceylon, 2. Parasitology, vol. 29, no. 4, pp. 435–452, figs. 1–107.

1964. A review of the parasitic copepods of fish recorded from Ceylon with descriptions of additional forms. Bull. Fish. Res. Sta. Ceylon, vol. 17, no. 1, pp. 45–132, figs. 1–191.

KNER, R.

1859. Über mänchen und weibchen von *Euryphorus nordmanni* M. Edw. Sitzungsb. Akad. Wiss. Wien (Math.-Naturwiss.), vol. 34, pp. 268–274, figs. 1–3.

KRØYER, H.

1835. Om Snyltekrebsene, isaer med Hensyn til den Danske Fauna: Om Lernaeerne i Almindelighed. *In* Naturhistorisk Tidsskrift, vol. 1, no. 2, pp. 172–189, pl. 2.

1838. Om Snyltekrebsene, isaer med Hensyn til den Danske Fauna. *In* Naturhistorisk Tidsskrift, vol. 2, pp. 8–52, pl. 1; pp. 131–137, pl. 3.

1863. Bidrag til Kundskab om Snyltekrebsene. *In* Naturhistorisk Tidsskrift, pp. 75–320, pls. 1–18.

KURIAN, C. V.

1955. Parasitic copepods of Travancore-Cochin. Bull. Cent. Res. Inst. Univ. Travancore, ser. C, vol. 4, no. 1, pp. 103–116, figs. 1–38.

1961. Parasitic copepods of fishes from Kerala. Bull. Cent. Res. Inst. Univ. Kerala, ser. C. (Nat. Sci.), vol. 8, no. 3, pp. 63–77, figs. 1–37.

LEIGH-SHARPE, W. H.

1926. A list of parasitic Copepoda found at Plymouth. Parasitology, vol. 28, no. 4, pp. 384–386, fig. 1.

1928. The genus *Pennella* (Copepoda) as represented by the collection in the British Museum. Parasitology, vol. 20, no. 1, pp. 79–89, figs. 1–7.

1930. Resultats scientifiques du voyage aux Indes Orientales Néerlandaises de LL. AA. RR. le Prince et la Princesse Léopold de Belgique, vol. 3, no. 2, pp. 1–9, pls. 1–5.

1931. *Pennella germonia* n. sp., a parasitic copepod of *Germo alatunga* [sic]. Parasitology, vol. 23, no. 1, pp. 109–111, 1 fig.

1933. A list of British fishes with their characteristic parasitic Copepoda. Parasitology, vol. 25, no. 1, pp. 109–112.

1934. The Copepoda of the *Siboga* Expedition, 2: Commensal and parasitic Copepoda. No. 123 (vol. 29b) *in* Weber, *Siboga* Expeditie . . ., viii + 44, 39 figs.

1935. *Anchistrotos laqueus* n. sp., a parasitic copepod of *Serranus cabrilla*. Parasitology, vol. 27, no. 2, pp. 266–269, figs. 1–3.

1936. New parasitic Copepoda from Naples. Parasitology, vol. 28, no. 1, pp. 63–71, figs. 1–9.

LEWIS, A. G.

1963. Life history of the caligid copepod *Lepeophtheirus dissimulatus* Wilson, 1905 (Crustacea: Caligoida). Pacific Sci., vol. 17, no. 2, pp. 195–242, figs. 1–20.

1964a. Caligoid copepods (Crustacea) of the Hawaiian Islands: parasitic on fishes of the family Acanthuridae. Proc. U.S. Nat. Mus., vol. 115, no. 3482, pp. 137–244, figs. 1–24.

1964b. The caligid copepod genus *Dentigryps* (Crustacea: Caligoida). Proc. U.S. Nat. Mus., vol. 115, no. 3487, pp. 347–380, figs. 1–13.

1966. Copepod crustaceans parasitic on elasmobranch fishes of the Hawaiian Islands. Proc. U.S. Nat. Mus., vol. 118, no. 3524, pp. 57–154, figs. 1–40.

LINTON, E.

1907. Notes on parasites of Bermuda fishes. Proc. U.S. Nat. Mus., vol. 33, no. 1560, pp. 85–126, pls. 1–2.

MARUKAWA, H.
*1925. *In* Illustrated encyclopaedia of the fauna of Japan, 1243 pp., 2396 figs.
*1947. *In* Illustrated encyclopaedia of the fauna of Japan, exclusive of Insecta, rev. ed., 927 pp., 2654 figs.

MICULICICH, V. M.
1904. Ein neuer Lernaeopodide. Zool. Anz., vol. 28, no. 2, pp. 47–52, figs. 1–2.
1905a. Zur Kenntnis der Gattung *Brachiella* Cuv. und der Organisation der Lernaeopodiden. Zool. Anz., vol. 28, no. 18, pp. 599–620, figs. 1–7.
1905b. Weitere Mitteilungen zur Kenntnis der Gattung *Brachiella* Cuv. Nach trag zu dem Aufsatz in Nr. 18 des Zoologischen Anzeigers. Zool. Anz., vol. 28, nos. 21, 22, pp. 733–736.

MILNE-EDWARDS, M. H.
1840. Histoire naturelle des Crustacés, vol. 3, 638 pp.; plates, 32 pp. + 42 pls.

MÜLLER, O. F.
1785. Entomostraca, seu Insecta testacea, quae in aquis Daniae et Norvegiae reperit, descripsit et iconibus illustravit, iv + 134 pp., 21 col. pls.

MURRAY, A.
1856. Description of a new species of *Echeneis* (*E. tropicus*); and of a new lernaean of the genus *Pennella* (*P. remorae*), infesting the *Echeneis* remora; with some remarks on the economy of the remora, Edinburgh New Philos. Journ., n.s. vol. 4, pp. 287–301, 5 figs.

NORDMANN, A. V.
1832. Mikrographische Beiträge zur Naturgeschichte der wirbellosen Thiere, 2 vols. [in one] , 150 pp., 10 pls.
1864. Neue Beiträge zur Kenntniss Parasitischer Copepoden. Bul. Soc Imp. Nat. Moscou, vol. 37, no. 4, pp. 461–519, pls. 5–8.

NORMAN, A., AND SCOTT, T.
1906. The Crustacea of Devon and Cornwall, xv + 232 pp., 24 pls.

NUNES-RUIVO, L.
1953. Copépodes parasites de poissons: Résultats des Campagnes du "Prof. Lacaze-Duthiers" en Mediterranée, Algérie, 1952. Vie et Milieu, suppl. 3, 24 pp., 11 figs.
1954. Parasites de poissons de mer ouest-africains récoltés par M. J. Cadenat III: Copépodes (2e note): Genres *Prohatshekia* [sic] n. gen. et *Hatschekia* Poche. Bull. Inst. Français d'Afrique Noire, ser. A, vol. 16, no. 2, pp. 479–505, figs. 1–14.
1956. Copépodes parasitas de peixes dos Mares de Angola. Anais Junta Invest. Ultramar, vol. 9, pt. 2, pp. 3–39, figs. 1–7.
1957. Lernaeopodidae (Copepoda) parasites des Trigles. Rev. Portuguesa Zool. Biol. Ger., vol. 1, pp. 89–107, figs. 1–5.
1962a. Copépodes parasites de poissons des côtes d'Angola. Mem. Junta Invest. Ultramar, vol. 33, pp. 67–86, figs. 1–8.
1962b. Copépodes parasitas de peixes das costas de Angola (Liste Faunistique). Notas Mimeogr. Centro Biol. Pisc. Lisboa, no. 33, 28 pp.

NUNES-RUIVO, L., and FOURMANOIR, P.
1956. Copépodes parasites de poissons de Madagascar. Mém. Inst. Sci. Madagascar, ser. A, vol. 10, pp. 69–80, figs. 1–8.

OKEN, L.

1816. Fleischthiere. Pt. 2 *of* Zoologie (vol. 3) *in* Okens Lehrbuch der Naturgeschichte, xvi + 1270.

OTTO, A. W.

1821. Conspectus animalium quorundam maritimorum nondum editorum pars prior, 20 pp.,

1828. Beschreibung einiger neuen, in den Jahren 1818 und 1819 im Mitteländischen Meere gefundener Crustaceen. Nov. Act. Acad. Caes.-Leop.-Carol., vol. 14, pt. 1, pp. 331-354, pls. 21-23.

PAIVA, CARVALHO T. DE P.

1956. *Caligus oligoplitisi* sp. n. copepodo parasito del "Zapatero" *Oligoplitis saliens* (Block). Neotropica, vol. 2, no. 7.

PEARSE, A. S.

1948. A second report on parasitic copepods collected at Beaufort, N.C. Journ. Elisha Mitchell Sci. Soc., vol. 64, no. 1, pp. 127–131, figs. 1–18.

1952a. Parasitic Crustacea from the Texas coast. Publ. Inst. Mar. Sci., vol. 2, no. 2, pp. 5–42, figs. 1–157.

1952b. Parasitic crustaceans from Alligator Harbor, Florida. Quart. Journ. Florida Acad. Sci., vol. 15, no. 4, pp. 187–243, figs. 1–143.

1954. Parasitic Crustacea from Bimini, Bahamas. Proc. U.S. Nat. Mus., vol. 101, no. 3280, pp. 341–372, figs. 67–77.

PILLAI, N. K.

1961. Copepods parasitic on south Indian fishes, 1: Caligidae. Bull. Cent. Res. Inst. Univ. Kerala Trivandrum, vol. 8, pp. 87–130, figs. 1–23.

1962a. Copepods parasitic on south Indian fishes families Lernaeopodidae and Naobranchidae. Journ. Mar. Biol. Assoc. India, vol. 4, no. 1, pp. 58–94, figs. 1–22.

1962b. Observations on the synonymy of *Caligus coryphaenae* Stp. & Ltk. Ann. Mag. Nat. Hist., ser. 13, vol. 5, no. 57, pp. 513–522, figs. 1–4.

1963. Copepods parasitic on south Indian fishes—family Caligidae. Journ. Mar. Biol. Assoc. India, vol. 5, no. 1, pp. 68–96, figs. 1–15.

POCHE, F.

1902. Bemerkungen zu der arbeites Herrn Bassett-Smith, "A systematic description of parasitic Copepoda found on fishes, with an enumeration of the known species." Zool. Anz. vol. 26, pp. 8–20.

POISSON, R., and RAZET, P.

1953. A propos des pennelles (crustacés copépodes) parasites des germons, *Pennella germania fagei* nov. subsp. Ann. Sci. Nat. Zool., ser. 11, vol. 15, nos. 3, 4, pp. 397–403, figs. 1–4.

QUIDOR, A.

1906. Sur les copépodes recueillis par la mission Jean Charcot dans les mers Antarctiques. Bull. Mus. Hist. Nat., vol. 1, pp. 1–6, figs. 1–48.

1910. Note préliminaire sur *Pennella balaenopterae* (Koren et Danielssen). Bull. Mus. Hist. Nat., vol. 16, no. 2, pp. 97–98.

1912. Copépodes parasites. In Deuxième Expédition Antarctique Française (1908–1910), pp. 197–215, pls. 1–4.

RANDALL, J. E.
1958. A review of the labrid fish genus *Labroides*, with descriptions of two new species and notes on ecology. Pacific Sci., vol. 12, no. 4, pp. 327–347, 1 pl., figs. 1–6.
1961. The biology of the convict surgeonfish. Pacific Sci., vol. 15, no. 2, pp. 215–272, figs. 1–25.

RANGNEKAR, M. P.
1956. Parasitic copepods from the marine fishes of Bombay. Journ. Univ. Bombay, vol. 24, no. 5, pp. 42–65, 7 figs.

RAO, T. S. S.
1951. On a new caligid parasite, *Gloiopotes zeugopteri* sp. nov., from *Xiphias zeugopteri*, Lawson's Bay, Waltair. Proc. Indian Acad. Sci., vol. 34B, pp. 248–255, figs. 1–15.

RATHBUN, M. J.
1905. Fauna of New England, 5: List of the Crustacea. Occ. Pap. Boston Soc. Nat. Hist., vol. 7, pp. 117+11.

RATHBUN, RICHARD
1884. Annotated list of the described species of parasitic Copepoda (Siphonostoma) from American waters contained in the United States National Museum. Proc. U.S. Nat. Mus., vol. 7, no. 31, pp. 483–492

REDKAR, M. V.; RANGNEKAR, P. G.; and MURTI, N. N.
1949. Four new species of parasitic copepods from the marine fishes of Bombay. Journ. Univ. Bombay, vol. 18, no. 3, pp. 36–50, figs. 1–44.
1950. Two new species of *Hatschekia* parasitic on Bombay fishes. Journ. Univ. Bombay, vol. 19, no. 3, pp. 35–42, figs. 1–14.

RICHIARDI, S.
1870. Intorno ad una nuova specie del genere *Bomolochus* (*B. ostracionis*). Arch. Zool. Anat. Fisiol., ser. 2, vol. 2, pp. 47–59, 1 pl.
1880. Catalogo sistematico dei crostacei che vivono sul corpo degli animali aquatici in Italia, pp. 147–152.

ROUNDS, H. D.
1960. *Anchistrotos hematus* n. sp., a parasitic copepod from *Serranus scriba*. Trans. American Micros, Soc., vol. 79, no. 4, pp. 485–488, pls. 1–2.

SCOTT, A.
1906. Faunistic notes. Proc. Trans. Biol. Soc. Liverpool, vol. 20, pp. 191–201, pls. 2–7.
1929. The copepod parasites of Irish Sea fishes. *In* Report of the 1928 Lancashire Sea-Fisheries Laboratory, University of Liverpool, pp. 81–118, pls. 1–3.

SCOTT, T.
1894. Report on Entomostraca from the Gulf of Guinea. Trans. Linn. Soc. London, vol. 6, no. 1, pp. 1–161, pls. 1–15.
1901. Notes on some parasites of fishes. Nineteenth Ann. Rep. Fish. Bd. Scotland, pt. 4, pp. 120–152, pls. 7, 8.
1902. Notes on some parasites of fishes. Twentieth Ann. Rep. Fish. Bd. Scotland, pt. 3, pp. 288–303, pls. 12,13.
1909. Some notes on fish parasites. Twenty-sixth Ann. Rep. Fish. Bd. Scotland, pt. 3, pp. 73–92, pls. 3–7.

SCOTT, T. and SCOTT, A.
1913. The British parasitic Copepoda, vol. 1, x + 256 pp., 2 pls.; Atlas (vol. 2), xii pp., 72 pls. [Publ. by Ray Society, London.]

Shiino, S. M.

1952. Copepods parasitic on Japanese fishes, 1: On the species of *Caligus* and *Lepeophtheirus*. Rep. Fac. Fish. Pref. Univ. Mie, vol. 1, no. 2, pp. 79–113, figs. 1–14.

1954a. Copepods parasitic on Japanese fishes, 3: On two new species of the genus *Anuretes*. Rep. Fac. Fish. Pref. Univ. Mie, vol. 1, no. 3, pp. 260–272, figs. 1–5.

1954b. Copepods parasitic on Japanese fishes, 4: The family Euryphoridae. Rep. Fac. Fish. Pref. Univ. Mie, vol. 1, no. 3, pp. 273–290, figs. 1–6.

1954c. Notes on *Caligus quadratus* n. sp., a copepod parasitic on the fish, *Neothynnus macropterus* (T. & S.). Bull. Japanese Soc. Sci. Fish., vol. 20, no. 1, pp. 26–29, 1 fig.

1954d. On the parasitic copepod, *Lepeophtheirus watanabei* n. sp., found on the fish *Myxocephalus raninus* J. & S. Bull. Japanese Soc. Sci. Fish., vol. 20, no. 2, pp. 96–100, 1 fig.

1954e. Note on a new parasitic copepod, *Caligus brevis* n. sp. Bull. Japanese Soc. Sci. Fish., vol. 20, no. 3, pp. 178–183, figs. 1–2.

1954f. On the male form of the copepod, *Caligus katuwo* Yamaguti, parasitic on the Japanese bonito *Euthynnus pelamys* (L.). Zool. Mag., vol. 63, pp. 246–249, 1 fig.

1955a. A. new piscicola copepod belonging to the genus *Caligus* from Matusima Bay. Bull. Biogeogr. Soc. Japan, vols. 16–19, pp. 135–140, figs. 1–3.

1955b. On the male of *Caligus cordiventris* Shiino. Zool. Mag., vol. 64, no. 3, pp. 65–67, 1 fig.

1956a. Copepods parasitic on Japanese fishes, 10: The redescription of three species of *Caligus*. Rep. Fac. Fish. Pref. Univ. Mie, vol. 2, no. 2, pp. 233–241, figs. 1-4.

1956b. Copepods parasitic on Japanese fishes, 12: Family Lernaeopodidae. Rep. Fac. Fish. Pref. Univ. Mie, vol. 2, no. 2, pp. 269–311, figs. 1–20.

1957a. Copepods parasitic on Japanese fishes, 13: Parasitic copepods collected off Kesennuma, Miyagi Prefecture. Rep. Fac. Fish. Pref. Univ. Mie, vol. 2, no. 3, pp. 359–375, figs. 1–6.

1957b. Copepods parasitic on Japanese fishes, 14: Three species from *Spheroides alboplumbeus* (Richardson). Rep. Fac. Fish. Pref. Univ. Mie, vol. 2, no. 3, pp. 376–391, figs. 1–7.

1957c Copepods parasitic on Japanese fishes, 15: Eudactylinidae and Dichelesthiidae. Rep. Fac. Fish. Pref. Univ. Mie, vol. 2, no. 3, pp. 392–410, figs. 1–7.

1957d. Copepods parasitic on Japanese fishes, 16: Bomolochidae and Taeniacanthidae. Rep. Fac. Fish. Pref. Univ. Mie, vol. 2, no. 3, pp. 411–428, figs. 1–6.

1958. Parasitic copepods from fishes collected in the Indian Ocean. Ann. Rep. Pref. Univ. Mie, sec. 2, vol. 2, no. 3, pp. 98–113, figs. 1–6.

1959a. Sammlung der parasitischen Copepoden in der Präfekturuniversität von Mie. Rep. Fac. Fish. Pref. Univ. Mie, vol. 3, no. 2, pp. 334–374, figs. 1–17.

1959b. Revision der auf Goldmakrele, *Coryphaena hippurus* L., schmarotzenden Caligidenarten. Ann. Rep. Pref. Univ. Mie, sec. 2, vol. 3, no. 1, pp. 1–34, figs. 1–9.

1959c. Neuer Artname für japanische Exemplare von *Caligus bonito*. Bull. Biogeogr. Soc. Japan, vol. 20, no. 11, pp. 51–57, figs. 1–2.

SHIINO, S. M.

1959d. Ostpazifische parasitierende Copepoden. Rep. Fac. Fish. Pref. Univ. Mie, vol. 3, no. 2, pp. 267–333, figs. 1–25.

1960a. Copepods parasitic on the fishes collected on the coast of Province Shima, Japan. Rep. Fac. Fish. Pref. Univ. Mie, vol. 3, no. 3, pp. 471–500, figs. 1–10.

1960b. Parasitic copepods of fishes from the eastern Pacific. Rep. Fac. Fish. Pref. Univ. Mie, vol. 3, no. 3, pp. 527–541, figs. 1–6.

1960c. Copepods parasitic on remoras from the Bay of Bengal. Rep. Fac. Fish. Pref. Univ. Mie, vol. 3, no. 3, pp. 542–552, figs. 1–4.

1963a. Parasitic copepods of the eastern Pacific fishes. Rep. Fac. Fish. Pref. Univ. Mie, vol. 4, no. 3, pp. 335–347, figs. 1–4.

1963b. Parasitic copepods of the eastern Pacific fishes, 4: On *Clavellistes shoyoae* gen. et sp. nov. Rep. Fac. Fish. Pref. Univ. Mie, vol. 4, no. 3, pp. 369–375, figs. 1–2.

STEBBING, T. R. R.

1900. On Crustacea brought by Dr. Willey from the south seas. No. 33 *of* pt. 5 *in* Willey, Zoological Results . . ., pp. 605–690, pls. 64–74.

1910. General catalogue of South African Crustacea (Part V of S. A. Crustacea, for the Marine Investigations in South Africa). Ann. South African Mus., vol. 6, pt. 4, pp. 281–593, pls. 15–21.

STEENSTRUP, J. J. S., and LÜTKEN, C. F.

1861. Bidrag til Kundskab om det aabne Havs Snyltekrebs og Lernaeer samt om nogle andre nye eller hidtil kun ufuldstaendigt kjendte parasitiske copepoder. Kongel. Danske Vidensk. Selsk. Skr. Naturh. Math. Afdel., 5 R., vol. 5, pp. 341–432, pls. 1–15.

STENTA, M.

1904. *Thynnicola ziegleri* Miculicich = *Brachiella thynni* Cuv. Zool. Anz., vol. 28, nos. 8–9, p. 345.

STOSSICH, M.

*1880. Prospetto della fauna del mare Adriatico. Boll. Soc. Adriatica Sci. Nat. Trieste, vol. 5, pp. 178–271.

STUARDO, J., and FAGETTI, E.

1961. Copepodos parasitos Chilenos, 1: Una lista de las especies conocidas y descripcion de tres especies nuevas. Rev. Chilena Hist. Nat., vol. 55, pp. 55–82, figs. 1–7.

THOMPSON, I. C., and SCOTT, A.

1903. On the copepoda. Suppl. rep. VII *in* Report to the Government of Ceylon on the pearl oyster fisheries of the Gulf of Manaar, pp. 227–307, pls. 1–20.

THOMSEN, R.

1949. Copépodos parásitos de los peces marinos del Uruguay. Comm. Zool. Mus. Hist. Nat. Montevideo, vol. 3, no. 54, pp. 1–41, pls. 1–14.

THOMSON, G. M.

1889. Parasitic Copepoda of New Zealand, with descriptions of new species. Trans. Proc. New Zealand Inst., vol. 22, pp. 353–376, pls. 25–29.

VALLE, A. DELLA

*1880. Crostacei parassiti dei pesci del mare Adriatico. Boll. Soc. Adriatica Sci. Nat., vol. 6, pp. 55–90.

*1882. Aggiunte ai crostacei parassiti dei perci del mare Adriatico. Boll. Soc. Adriatica Sci. Nat., vol. 7, pp. 245–247.

Van Beneden, P. J.
1851. Recherches sur quelques Crustacés inférieurs. Ann. Sci. Nat., sér. 3 (Zool.), vol. 16, pp. 71–131, pls. 2–6.
1861. Recherches sur les Crustacés du littorale de Belgique. Bull. Acad. Roy. Sci. Belgique, vol. 33, no. 3, 174 pp.
1870a. Les poissons des côtes de Belgique, leurs parasites et leurs commensaux, xx + 100 pp., 8 pls.
1870b. Recherches sur l'embryogénie des Crustacés, 4: Développement des genres *Anchorella*, *Lerneopoda*, *Brachiella* et *Hessia*. Bull. Acad. Roy. Sci. Belgique, pp. 225–254, 1 pl.

Vogt, C.
*1877. Recherches cotières faites à Roscoff: crustacés parasites des poissons. Arch. Zool. Expèr. Gen., vol. 6, pp. 385–456.

Wierzejski, A.
1877. Ueber Schmarotzerkrebse von Cephalopoden. Zeitschr. Wiss. Zool., vol. 29, pp. 562–582, pls. 32–34.

Wilson, C. B.
1905a. New species of parasitic copepods from the Massachusetts coast. Proc. Biol. Soc. Washington, vol. 18, pp. 127–132.
1905b. North American parasitic copepods belonging to the family Caligidae, 1: The Caliginae. Proc. U.S. Nat. Mus., vol. 28, no. 1404, pp. 479–672, pls. 5–28, figs. 1–50.
1907a. North American parasitic copepods belonging to the family Caligidae, 2: The Trebinae and Euryphorinae. Proc. U.S. Nat. Mus., vol. 31, no. 1504, pp. 669–720, pls. 15–20
1907b. North American parasitic copepods belonging to the family Caligidae, 3 and 4: A revision of the Pandaranae and the Cecropinae. Proc. U.S. Nat. Mus., vol. 33, no. 1573, pp. 323–490, pls. 17–43.
1908. North American parasitic copepods: A list of those found upon the fishes of the Pacific coast, with descriptions of new genera and species. Proc. U.S. Nat. Mus., vol. 35, no. 1652, pp. 431–481, pls. 66–83.
1910. North American parasitic copepods, 9: The Lernaeopodidae. Proc. U.S. Nat. Mus., vol. 39, no. 1783, pp. 189–226, pls. 29–36.
1911a. North American parasitic copepods belonging to the family Ergasilidae. Proc. U.S. Nat. Mus., vol. 39, no. 1788, pp. 263–400, pls. 41–60, figs. 1–41.
1911b. North American parasitic copepods: Descriptions of new genera and species. Proc. U.S. Nat. Mus., vol. 39, no. 1805, pp. 625–634, pls. 65–68.
1913. Crustacean parasites of West Indian fishes and land crabs, with descriptions of new genera and species. Proc. U.S. Nat. Mus., vol. 44, no. 1950, pp. 189–227, pls. 18–53.
1915. North American parasitic copepods belonging to the Lernaeopodidae, with a revision of the entire family. Proc. U.S. Nat. Mus., vol. 47, no. 2063, pp. 565–729, pls. 25–56, figs. 1–15.
1917. North American parasitic copepods belonging to the Lernaeidae, with a revision of the entire family. Proc. U.S. Nat. Mus., vol. 53, no. 2194, pp. 1–150, pls. 1–21, figs. a–c.
1919. A new species of parasitic copepod, with notes on species already described. Proc. U.S. Nat. Mus., vol. 55, no. 2274, pp. 313–316, pl. 21.

WILSON, C. B.
1921. New species and a new genus of parasitic copepods. Proc. U.S. Nat. Mus., vol. 59, no. 2354, pp. 1–17, pls. 1–7.
1922. North American parasitic copepods belonging to the family Dichelesthiidae. Proc. U.S. Nat. Mus., vol. 60, no. 2400, pp. 1–100, pls. 1–13.
1923. Parasitic copepods in the collection of the Riksmuseum at Stockholm. Ark. Zool., vol. 15, no. 3, pp. 1–15, pls. 1–2.
1924. Parasitic copepods from the Williams Galapagos Expedition. Zoologica, New York Zool. Soc., vol. 5, no. 19, pp. 212–217, pl. 20.
1932. The copepods of the Woods Hole region, Massachusetts. U.S. Nat. Mus. Bull., vol. 158, xix + 635 pp., 41 pls., 316 figs.
1935a. Reports on the collections obtained by the first Johnson-Smithsonian Deep-Sea Expedition to the Puerto Rican Deep. Smithsonian Misc. Coll., vol. 91, no. 19, pp. 1–9, pls. 1–3.
1935b. Parasitic copepods from the Dry Tortugas. Carnegie Inst. Washington, publ. 452, Pap. Tortugas Lab., vol. 29, no. 12, pp. 327–347, pls. 1–6.
1936. Note on a copepod from Cuba. Mem. Soc. Cubana Hist. Nat., vol. 10, no. 1, p. 32.
1937. Some parasitic copepods from Panama Bay. Journ. Washington Acad. Sci., vol. 27, no. 10, pp. 423–431, figs. 1–34.

YAMAGUTI, S.
1936a. Caligoida, I. Pt. 2 *in* Parasitic copepods from fishes of Japan, 22 pp. 12 pls. [Publ. by author.]
1936b. Caligoida, II. Pt. 3 *in* Parasitic copepods from fishes of Japan, 21 pp., 9 pls. [Publ. by author.]
1939a. Cyclopoida, II. Pt. 4 *in* Parasitic copepods from fishes of Japan, pp. 391–415, pls. 1–13. [Vol. Jub. pro Prof. Sadao Yoshida, vol. 2.]
1939b. Caligoida, III. Pt. 5 *in* Parasitic copepods from fishes of Japan, pp. 443–487, pls. 14–33. [Vol. Jub. pro Prof. Sadao Yoshida, vol. 2.]
1939c. Lernaeopoida, I. Pt. 6 *in* Parasitic copepods from fishes of Japan, pp. 529–578, pls. 34–58. [Vol. Jub. pro Prof. Sadao Yoshida, vol. 2.]
1953. Cyclopoida, III, and Caligoida, IV. Pt. 7 *in* Parasitic copepods from fishes of Japan. Publ. Seto Mar. Biol. Lab., vol. 3, no. 2, pp. 221–231, pls. 1–5.
1954. Parasitic copepods from fishes of Celebes and Borneo. Publ. Seto Mar. Biol. Lab., vol. 3, no. 3, pp. 375–398, pls. 1–6.
1963. Parasitic Copepoda and Branchiura of fishes, vii + 1104 pp., 333 pls.

YAMAGUTI, S., and YAMASU, T.
1959. Parasitic copepods from fishes of Japan with descriptions of 26 new species and remarks on two known species. Biol. Journ. Okayama Univ., vol. 5, nos. 3, 4, pp. 89–165, pls. 1–14.

U S. GOVERNMENT PRINTING OFFICE: 1967